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Draft Environmental Impact Statement Proposed Wastewater Treatment Facilities for Eastern St. Charles County, Missouri including Duckett Creek Sewer District, St. Peters Sewer District, St. Charles Sewer District Portage de Sioux Sewer District

WAPORA, Inc., Chevy Chase, MD

Prepared for

Environmental Protection Agency, Kansas City, MO

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Environmental Review

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EPA

Environmental Impact Statement

Draft

Proposed Wastewater Treatment Facilities for Eastern St. Charles County, MO

including:
Duckett Creek Sewer District
St. Peters Sewer District
St. Charles Sewer District
Portage de Sioux Sewer District

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16. ABSTRACT

The draft environmental impact statement addresses the social, economic, and environmental impacts potentially resulting from the proposed Federal action of issuing a grant for construction of wastewater management facilities within the St. Charles County facilities planning area. The planning area includes the Duckett Creek Sewer District and the cities of St. Charles and St. Peters, Missouri. Communities served by the new system also include the Village of Portage des Sioux and other unincorporated areas of St, Charles County. St. Charles County, located between the Missouri and Mississippi River approximately, 25 miles from St. Louis, is one of the fastest growing counties in the U.S. The planning area has at least 23 treatment facilities of varying ages, capacities, and capabilities, and the southern portion has high population growth and urbanization.

The no-action alternative and four action alternatives were evaluated. The no-action alternative was determined to be unacceptable and would result in continual water quality degradation, public health risks, and property damage. Principal impact areas for the action alternatives include surface and groundwater quality, biological resources, and infrastructures. The recommended alternative was found to be environmentally sound and cost-effective. Most adverse impacts can be mitigated through various legal requirements, planning measures, and design/construction practices.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Sewage Treatment	Flood plains/ Wetlands	EIS	Environmental Eng
Sludge Disposal	Onsite Systems	Duckett Creek Sewer Auth	Biology; Hydrology
Flow and Waste Reduction	Regionalization	St. Charles County	Socioeconomics
Effluent Disposal	Environmental Impact	St. Peters; St. Charles	Geology
Collection Systems	Cost-Effectiveness	Portage de Sioux	Archaeology
Innovative/Alternative Treatment	Infiltration/ Inflow	Mississippi River	Planning
Alternative Analysis		Missouri River	Demography
			Transportation

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
726 MINNESOTA AVENUE
KANSAS CITY, KANSAS 66101

TO: ALL INTERESTED AGENCIES, PUBLIC GROUPS AND CITIZENS

Attached is a copy of the Draft Environmental Impact Statement (EIS) for Proposed Wastewater Treatment Facilities for Eastern St. Charles County, Missouri. This EIS includes the proposed facilities for the Duckett Creek, St. Peters, St. Charles, and Portage de Sioux Sewer Districts. The document is submitted pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969 (Public Law 91-190). All comments on this Draft EIS must be submitted to the Environmental Protection Agency (EPA) within 45 days after the Notice of Availability of this document is published in the Federal Register. This closing date for submitting comments is anticipated to be May 20, 1985. Additional copies of this document are available for public review at the following locations:

Kathryn M. Linnemann Branch Library
2323 Elm Street
St. Charles, Missouri

Spencer Road Branch Library
425 Spencer Road
St. Peters, Missouri

Please send your comments to the attention of Edward Vest, Chief, Environmental Impact Section, 726 Minnesota Avenue, Kansas City, Kansas 66101.

A public hearing will be held May 9, 1985, at 7 p.m., in the City Council Chambers of the St. Charles City Hall, at 200 North Second, St. Charles, Missouri 63301. All interested parties are invited to attend the public meeting and offer written or oral comments at that time.

Additional information on the document or the review period may be obtained from Thomas Lorenz at the above address, or by phoning (913) 236-2823 or (FTS) 757-2823.

Sincerely yours,

William Rice
for - Morris Kay
Regional Administrator

Attachment

DRAFT

ENVIRONMENTAL IMPACT STATEMENT
FOR PROPOSED WASTEWATER TREATMENT
FACILITIES FOR EASTERN ST. CHARLES
COUNTY, MO

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII, KANSAS CITY, KANSAS

MARCH, 1985

APPROVED BY:

for - William

Morris Kay, Regional Administrator

Consultant:

WAPORA, Inc.

Chevy Chase, Maryland

EXECUTIVE SUMMARY

PURPOSE OF AND NEED FOR ACTION

The eastern portion of St. Charles County is experiencing significant population growth and urbanization. As a result of past and projected growth in this area, improvements in wastewater collection and treatment facilities are necessary. In addition, some existing wastewater treatment plants have not been able to meet effluent limitations specified in their National Pollutant Discharge Elimination System (NPDES) permits due to hydraulic overloads, system deterioration, and related factors. Some areas currently served by onsite wastewater treatment systems also need improved wastewater systems since many existing systems are not providing an adequate level of treatment to safeguard public health.

In order to develop a plan for increasing wastewater treatment capacity and capabilities, as well as provide adequate collection facilities, a wastewater facilities planning study was initiated in 1981. The facilities planning area includes the cities of St. Charles and St. Peters, the Village of Portages des Sioux, and unincorporated portions of eastern St. Charles County. The facilities planning consultant, Sverdrup & Parcel and Associates, Inc., developed and evaluated several alternatives which would correct existing pollution problems and provide necessary improvements in wastewater collection and treatment capability and capacity.

The National Environmental Policy Act of 1969 (NEPA) requires a Federal agency to prepare an EIS on "...major Federal actions (e.g., funding of wastewater treatment and collection facilities) significantly affecting the quality of the human environment..." The Council on Environmental Quality (CEQ) has established regulations (40 CFR Parts 1500-1508) to guide Federal agencies in determinations of whether or not Federal funds or Federal approvals would result in a project that would significantly affect the environment. The U.S. Environmental Protection Agency (USEPA) has developed its own regulations (40 CFR Part 6) for the implementation of the EIS process. USEPA VII has determined that pursuant to these regulations, an EIS is required for this facilities planning effort.

Participants in the wastewater planning process during the past 3 years have included: the cities of St. Peters and St. Charles, the Village of Portage des Sioux, the Duckett Creek Sewer District, the state of Missouri, USEPA, Sverdrup & Parcel and Associates, Inc., WAPORA, Inc. (EIS consultant), and other Federal, state, local, and private agencies and organizations. A Citizens Advisory Committee (CAC) composed of local officials, local residents, and representatives of a number of local interest groups was formed to provide input into the planning process and has met at key decision points during the project. In particular, the CAC provided valuable input into the selection of alternatives considered most suitable for detailed engineering analysis. A public hearing on the Draft Facilities Plan also was held on 15 February 1984. Following publication of this Draft EIS, an additional public hearing will be held to discuss its conclusions and recommendations.

The following issues have been determined to be potentially significant and are addressed in this Draft EIS:

- Induced population growth which could result in concomitant impacts on:
    - floodplains
    - wetlands
    - hazardous areas
    - prime and unique agricultural areas
    - wildlife habitat areas
    - threatened and endangered species
    - historic and archaeological sites
- The effects of effluent discharges on the water quality of the Missouri and Mississippi rivers.
- The development of a user charge system acceptable to a population that is currently being served by numerous systems with varying user charges.
- The development of alternatives which satisfy the needs of numerous public and private entities with facilities that have widely ranging treatment capabilities, capacities, and design periods.
- The development of an equitable plan for compensating private utilities and public entities that have facilities which could be transferred to regional or subregional systems.
- Coordination between the public, EIS consultant, facilities planner, USEPA, MDNR, Duckett Creek Sewer District, the cities of St. Charles and St. Peters, St. Charles County, and private utility companies.

- Construction impacts, including disruption of traffic flows with attendant impacts on land use, local businesses, and residents' commuting patterns.

WASTEWATER MANAGEMENT ALTERNATIVES

Eight preliminary alternatives for collection and treatment of wastewater in the planning area were identified. These alternatives involved eight interceptor sewer system configurations that would transport wastewater from the six sewer service subareas within the planning area to various sewage treatment plants (STPs). Some elements that were common to each alternative include the eventual abandonment of five STPs and six pump stations. The five STPs to be abandoned include: Highway 94-South STP, St. Charles Trails STP, Heatherbrook Lagoon, Boschertown Lagoon, and Riverview Hills Septic Tank. Sewage pumping stations to be abandoned include: Riverview Drive, Bedford Mobile Park, Princess Jodi Mobile Park, Hutchins Metals, Heatherbrook No. 1, and Heatherbrook No. 2. Depending on the alternative finally selected, the following STPs would be abandoned, expanded, or upgraded: Mississippi River STP, Spencer Creek STP, Harvester-Dardenne STP, and Missouri River STP.

For each municipal STP to be utilized under the eight preliminary alternatives, various treatment and disposal options were considered by the facilities planner. These eight preliminary alternatives were screened by the facilities planner to select four alternatives for detailed evaluation. Screening factors that were considered included: costs, environmental constraints, reliability, flexibility, and implementability.

The four wastewater management alternatives selected for detailed analysis by the facilities planner involved the continued use of three or four municipal STPs throughout the 20-year planning period. The Highway 94-South STP would become an interim treatment facility under each alternative. A No Action Alternative was also considered. These alternatives are briefly described in the following paragraphs.

No Action

The "No Action" Alternative assumes that no Federal, state, or local funds would be provided to build and/or upgrade wastewater management systems.

Existing wastewater management problems largely would remain unsolved, and new problems would likely develop during the 20-year planning period. For example, within the City of St. Charles, the Missouri River STP is not meeting secondary effluent limitations specified in the NPDES permit established for the facility. The plant is currently overloaded, therefore the likelihood of bypassing raw sewage to area streams, as a result of increased infiltration/inflow during storm events, would increase. Both the St. Charles Trails STP and the Heatherbrook Lagoon have not consistently met their established NPDES effluent limitations. It is unlikely that effluent limitations could be attained for both facilities unless some corrective action is taken. The consequences of no action would be to further degrade area streams due to the discharge of inadequately treated wastewater.

Within the City of St. Charles, the Spencer Creek STP does not consistently meet its NPDES effluent limitations for total suspended solids (TSS). Based on the results of a waste load allocation analysis for lower Dardenne Creek, it is expected that the STP will be required to remove ammonia in order to continue discharging effluent to Dardenne Creek. Due to existing facility design, the STP is not capable of providing ammonia removal, and an effluent pump would be required to convey effluent to the receiving stream during heavy rainfall events.

Within the Duckett Creek Sewer District, the Harvester-Dardenne STP, Highway 94-South STP, and Boschertown Lagoon have no, or minimal excess capacity for increased wastewater flows resulting from projected future development. Based on the waste load allocation analysis for lower Dardenne Creek, both the Harvester-Dardenne STP and the Highway 94-South STP would be required to remove ammonia if they continue to discharge effluent to Dardenne Creek. Due to existing design, neither STP is capable of removing ammonia from wastewater. Without any modifications, these three treatment plants are expected to be hydraulically overloaded, resulting in further degradation of effluent quality and water quality of the receiving stream. Dardenne Creek is currently being degraded due to the ammonia-nitrogen loading from the Harvester-Dardenne STP and Highway 94-South STP.

Areas served by onsite sewage treatment systems which have experienced problems would be expected to continue to have problems under the No Action Alternative. These problems would result in the continued degradation of local area streams, as well as present a potential health hazard.

Alternative 3

Alternative 3 would involve the continued use of the Spencer Creek STP, Duckett Creek STP, Missouri River STP, and Mississippi River STP. The Highway 94-South STP would serve as an interim treatment plant.

The Highway 94-South STP would initially be expanded and upgraded to a 1.0 mgd treatment plant. The plant would be operated until the interceptor system is constructed in 1989, which would transport wastewater from the South subarea to the Spencer Creek STP.

The Spencer Creek STP would be expanded to a 7.5 mgd secondary treatment plant. As indicated in the following table, the existing treatment plant would be converted to a contact stabilization activated sludge plant. An effluent chlorination system, effluent pump, and outfall to the Mississippi River would be constructed. Selected sludge treatment and disposal options, also summarized in the following table, would require construction of gravity thickeners and an aerobic digestion system, and installation of belt filter presses to dewater the sludge. Dewatered sludge would be disposed of by land application.

The existing Duckett Creek STP would be replaced by a new 1.0 mgd secondary treatment plant constructed on the existing plant site. The new facility would be an oxidation ditch activated sludge system with effluent discharged to Duckett Creek. New sludge treatment units would consist of gravity thickeners, anaerobic digesters, and belt filter presses. Sludge would be disposed of by land application.

The Missouri River STP would be expanded and upgraded from a 3.0 mgd primary facility to a 5.0 mgd secondary treatment plant. The selected liquid treatment and disposal options include the expansion of the existing primary treatment system and construction of an oxidation ditch system. Treated

SUMMARY OF SELECTED WASTEWATER AND SLUDGE TREATMENT/DISPOSAL OPTIONS EVALUATED IN THE DRAFT FACILITIES PLAN

LIQUID STREAM

Alternative Number(s)	STP	Activated Sludge Treatment Scheme	Disinfection	Effluent Disposal
3, 6, 8	Spencer Creek STP	Contact Stabilization	Chlorination	Pump to Mississippi River
3, 6, 7, 8	Duckett Creek STP	Oxidation Ditch	None	Gravity Flow to Duckett Creek
3, 6, 7, 8	Missouri River STP	Primary Sedimentation/ Oxidation Ditch	None	Gravity Flow To Missouri River
3	Mississippi River STP	Primary Sedimentation/Step Aeration	Chlorination	Gravity Flow to Mississippi River
6, 7, 8	Mississippi River STP	Primary Sedimentation/Step Aeration	Chlorination	Pump to Mississippi River

SLUDGE STREAM

Alternative Number(s)	STP	Sludge Stabilization	Sludge Thickening	Sludge Dewatering	Sludge Disposal
3, 6, 8	Spencer Creek STP	Aerobic Digestion	Gravity Thickeners	Belt Filter Press	Land Application
3	Duckett Creek STP	Anaerobic Digestion	Gravity Thickeners	Belt Filter Press	Land Application
6, 7, 8	Duckett Creek STP	Aerobic Digestion	Gravity Thickeners	Belt Filter Press	Land Application
3, 6, 7, 8	Missouri River STP	None	Gravity Thickeners	Filter Press	To Miss. River STP
3, 6, 8	Mississippi River STP	Incineration	Gravity Thickeners	Filter Press	Landfill (Ash)
7	Mississippi River STP	Aerobic Digestion/ Incineration	Gravity Thickeners	Belt Filter Press	Landfill (Ash)

effluent would continue to be discharged by gravity to the Missouri River. The selected sludge treatment and disposal options include construction of gravity thickeners and the addition of belt filter presses for sludge dewatering. The dewatered sludge would be hauled to the Mississippi River STP for incineration.

The Mississippi River STP would be expanded from a 5.5 mgd to a 7.0 mgd secondary treatment plant. The plant would continue to consist of primary sedimentation, step aeration activated sludge system, with chlorinated effluent flowing by gravity to the Mississippi River. Existing sludge treatment facilities would continue to be utilized. Proposed sludge facilities consist of gravity filters, filter presses, and an incineration system. Disposal of sludge incinerator ash would continue onsite, but ash would eventually be sent to a sanitary landfill.

Alternative 6 (Facility Plan Recommended Alternative)

Alternative 6 would involve the continued use of the Spencer Creek STP, Duckett Creek STP, Missouri River STP, and Mississippi River STP. As in Alternative 3, the Highway 94-South STP would serve as an interim facility.

Both Alternative 3 and Alternative 6 are similar since the Highway 94-South STP would initally be expanded and upgraded to a 1.0 mgd treatment plant. The plant would be operated until the interceptor system that would transport wastewater from the South Subarea to the Duckett Creek STP is constructed in 1989. The Spencer Creek STP would be upgraded, as described for Alternative 3; however, under Alternative 6, the plant would be expanded to a 4.0 mgd facility.

The existing Duckett Creek STP would be replaced by a new 5.0 mgd secondary treatment plant constructed on the existing plant site. The selected liquid treatment/disposal options are the same as those described for Alternative 3. The only difference between the selected sludge treatment/disposal options under Alternatives 3 and 6 is that sludge stabilization would be by aerobic digestion under Alternative 3 rather than by anaerobic digestion as proposed under Alternative 6.

The Missouri River STP would be expanded and upgraded as described under Alternative 3. There is no difference between any of the "action" alternatives with regard to the Missouri River STP. The Mississippi River STP would be expanded and upgraded to a 7.0 mgd secondary treatment plant. The expansion and upgrade scheme is similar to that described under Alternative 3. The only major difference between Alternatives 3 and 6 is that under Alternative 3, effluent would flow by gravity rather than be pumped to the Mississippi River.

Alternative 7

Alternative 7 would involve the continued use of the Duckett Creek STP, Missouri River STP, and Mississippi River STP. As with the other "action" alternatives, the Highway 94-South STP would serve as an interim facility and would be expanded and upgraded as described previously for the other "action" alternatives. However, the plant would be abandoned in 1995, when the interceptor system would be constructed to convey wastewater to the Mississippi River STP.

One major difference between the previously described "action" alternatives and Alternative 7 is that the Spencer Creek STP would be abandoned in 1995 under Alternative 7 rather than remaining operational throughout the 20-year planning period. Under Alternative 7, the Spencer Creek STP would become a pump station, and wastewater would be pumped to the Mississippi River STP for treatment.

The Duckett Creek STP would be replaced by a new 3.5 mgd secondary treatment plant constructed on the existing plant site. The treatment plant scheme would consist of the same treatment/disposal options for wastewater and sludge that were developed in Alternative 6. Furthermore, the Missouri River STP would be expanded and upgraded as described under Alternative 3. There is no difference between any of the "action" alternatives with respect to the Missouri River STP. The Mississippi River STP would be expanded and upgraded to a 12.0 mgd secondary treatment plant. The upgrade scheme is similar to that described under Alternative 6. The only major difference between Alternative 6 and Alternative 7 is that under the latter alternative, sludge would be aerobically digested, while under Alternative 6, sludge would not be digested.

Alternative 8

Alternative 8 would involve the continued use of the Spencer Creek STP, Duckett Creek STP, Missouri River STP, and Mississippi River STP. As in Alternatives 3, 6, and 7, the Highway 94-South STP would serve as an interim facility would be expanded and upgraded as described in the previously presented "action" alternatives. However, the plant would be abandoned in 1995 when the interceptor system would be constructed to convey wastewater to the Spencer Creek STP. The Spencer Creek STP would be upgraded, as described for Alternative 3. Under Alternative 8, the plant would be expanded to a 5.0 mgd facility.

The Duckett Creek STP would be replaced by a new 3.5 mgd facility, as described for Alternative 7. There is no difference between Alternatives 7 and 8 with regard to the Duckett Creek STP replacement plant. Furthermore, the Missouri River STP would be expanded and upgraded to 5.0 mgd, as described under the other "action" alternatives. The Mississippi River STP would be expanded to a 7.0 mgd facility, as described under Alternative 6. There is no difference between Alternatives 6 and 8 with regard to the Mississippi River STP expansion.

Description of the Facility Plan Recommended Alternative

The facilities planner evaluated four "action" alternatives with respect to costs and non-monetary considerations. A cost-effectiveness analysis was developed and Alternative 6 had the lowest total present worth cost of $46,000,000. The three other alternatives were approximately 3 to 12 percent more costly based on their total present worth cost.

Non-monetary factors used in comparing alternatives included reliability, environmental effects, floodplain infringement, energy use, public approval, implementation capability, contributions to goals, and expandability. Environmental consequences from the construction and operation of the four final "action" alternatives and the No Action Alternative are summarized in another section of this Executive Summary.

In the draft and final facilities plans, Alternative 6 was selected as the most cost-effective system that would satisfy both the needs and requirements of the Duckett Creek Planning Area and fulfill environmental and regulatory requirements. Alternative 6 consists of expanding the Mississippi River and Spencer Creek STPs, constructing new facilities at the Missouri River and Duckett Creek STPs, and upgrading the existing wastewater collection and transmission system. Further, construction would begin in the near future, and various stages of the overall plan would be implemented at different times during the 20-year planning period.

Wastewater Collection and Conveyance Facilities

Under the Facility Plan Recommended Alternative, four major interceptor routes are proposed: (1) South Plant to the Harvester-Dardenne site; (2) Spencer Creek STP to the Mississippi River; (3) Boschertown lagoon to the Missouri River STP; and (4) St. Charles Trails STP to I-70.

Wastewater flows pumped from the South Plant service area would be intercepted by a gravity sewer. The sewer line would follow Dardenne Creek to a pumping station north of the Harvester-Dardenne STP, where the wastewater would be pumped to the Harvester-Dardenne pumping station. The Harvester-Dardenne pumping station would pump both the South Plant and the Harvester-Dardenne service area flows to a new 5 mgd Duckett Creek STP. Once the downstream treatment facilities are constructed, the interim South Plant would be eliminated. Effluent from the Spencer Creek STP would be pumped into the Mississippi River. The force main would follow Spencer Creek and then extend northward, across the floodplain, to the Mississippi River.

The Boschertown interceptor would extend from the Boschertown lagoon to the Missouri River STP. Gravity sewers would be used with an intermediate lift station. This interceptor would eliminate the Boschertown lagoon and the Hutchins, Riverview, Princess Jodi, and Bedford pumping stations.

The Missouri River interceptor stops at I-70. An extension of this sewer line would eliminate the St. Charles Trails STP, Timbercrest and Heatherbrook lagoons, Riverview Hills septic tank and sand filter, and Heatherbrook pumping stations numbers 1 and 2. The alignment of the sewer line would extend from the St. Charles Trails STP along Taylor Branch, and then follow the MK&T Railroad to the existing Missouri River interceptor.

Wastewater Treatment Facilities

Mississippi River STP -- The Mississippi River STP would be expanded from a capacity of 5.5 mgd to 7.0 mgd. The existing unit processes would be maintained; however, expansion or replacement of certain items would be required. A new effluent pumping station would be required. Currently, when the Mississippi River is at high stage, effluent wastewater must be pumped through an empty activated carbon filter to provide enough head to allow gravity flow to the river. The new pumping station would contain three centrifugal sewage pumps and would pump effluent through a force main to the river.

Missouri River STP -- The Missouri River STP would be expanded from a 3 mgd primary facility to a 5 mgd secondary system. The plant was built in 1966 and most of the mechanical equipment would require replacement. An oxidation ditch system is proposed to provide secondary treatment. The existing sludge handling system at the Missouri River STP currently is not used; however, the building could be modified to house the new sludge dewatering equipment. Dewatered sludge cake would be trucked to the Mississippi River STP for incineration.

Duckett Creek STP -- The 1 mgd Duckett Creek package plant would be replaced by a 5 mgd treatment facility. None of the existing equipment would be used at the new plant. Oxidation ditches would provide secondary treatment. Waste activated sludge would be thickened in a gravity thickener prior to stabilization in two aerobic digesters. The digested sludge would then be dewatered by two belt filter presses.

Ultimate disposal of dewatered sludge would be by land application, when possible. Sufficient (30-day) cake storage facilities and alternate sludge disposal methods, including landfilling, would be necessary. The proposed plan includes onsite storage, land application of sludge to the greatest extent possible, or landfilling of sludge cakes. Final application sites currently are not known, but would be selected during the project design stage.

Sludge disposal facilities and equipment would include a sludge storage shed for the dewatered cake, and a land application truck and a feeder tank truck would be required for farmland subsurface injection. Sludge cake would be produced when land application is not feasible and stored until it could be applied to land or until storage capacity is reached, whereupon the sludge would be hauled to a landfill for final disposal.

Spencer Creek Plant -- The Spencer Creek STP would require upgrading from a 3.0 mgd extended aeration plant to a 4.0 mgd contact stabilization plant. Much of the existing equipment was installed in 1980 and could be utilized in this upgrading plan. Effluent would be pumped to the Mississippi River rather than discharged to the Spencer Creek, as currently practiced. To handle sludge, a gravity thickener would be added prior to aerobic digestion. Two new digesters would replace the original digester. Digested sludge would be dewatered by two belt filter presses housed in a new sludge handling building.

The City of St. Peters is investigating land application of sludge since the existing sludge handling method (lagoon) is not acceptable. The use of a landfill is being considered as an alternate sludge disposal method. A flexible system, including storage facilities for dewatered sludge cake, would also be required.

Interim South and Interim Duckett Creek Plants -- In the draft facilities plan, an interim South Plant was determined to be needed to treat wastewater from the upper Dardenne watershed until the flow could be intercepted and pumped to the new Duckett Creek STP. The existing package plant could not handle the additional flows projected during the construction of the interceptor system and the new Duckett Creek STP, which are scheduled for completion in 1988. Therefore, expansion at the South Plant was proposed to accommodate the continuing development in the area. A 0.5 mgd contact stabilization plant was proposed in the facilities plan and would provide enough capacity to meet the interim demands. Due to the temporary nature of this plant, nitrification is not proposed.

The combined flow capacity of the Harvester-Dardenne and Duckett Creek plants is 2.0 mgd. As of July 1984, the Harvester-Dardenne and Duckett Creek plants were receiving 1.4 mgd and 0.6 mgd, respectively, for a total of 2.0 mgd. Once the Harvester-Dardenne pump station is completed, part of the excess flow (i.e., flow exceeding 1.0 mgd) could be diverted to the Duckett Creek Plant, so that both plants would initially be operating at capacity. Since this would allow no excess capacity to handle growth during construction of the new Duckett Creek Plant (not scheduled for completion until 1988), an additional interim package plant is proposed. It was determined in the final facilities plan that a 1.0 mgd contact stabilization plant would provide sufficient capacity to meet projected interim demands.

Portage des Sioux Plant -- The Portage des Sioux STP would be upgraded to a secondary facility. However, it is recommended that an extended aeration package plant be constructed in lieu of the 1978 selection of a rotating biological contactor plant.

Onsite Systems -- In the planning area, there are three general classifications of existing onsite system areas: (1) developments along the Mississippi River and in the floodplain that are serviced by individual shallow wells and onsite systems; (2) the upland portion of the planning area; and (3) residences in areas with karst topographic features, mainly around Taylor Branch. The final facilities plan concludes that the use of onsite systems in densely populated areas in the upland portions of the planning area (area 2), and further development in the karst areas (area 3), would be discontinued as interceptors are constructed.

Although the residences currently served by onsite systems in the Mississippi River floodplain (area 1) were originally recommended (in the draft facilities plan) to be served by centralized collection and treatment facilities where the density of residences was sufficient, it subsequently has been determined (by the facilities planner) that these floodplain communities cannot afford the cost of collection and transmission systems for treatment of wastewater at the nearest centralized facility. As such, a centralized collection system for the major floodplain communities was not considered implementable. Instead, a plan was proposed that could mitigate problems without being capital-intensive. The proposed plan would include the following measures:

- establishment of a centralized management agency responsible for planning and supervising the upgrading and maintenance of onsite systems;
- a public education program on proper septic tank and absorption field operation;
- emphasis on the need for community wells to replace individual shallow wells;
- consideration of cluster systems;
- consideration of holding tanks for riverfront properties; and
- flow conservation practices and devices to reduce the load on existing onsite systems.

The continued use of onsite systems in the upland areas also would still be necessary for numerous residences because interceptor sewers are not and will not be located sufficiently close to provide service. Sufficient data have not been presented in the facilities plan to ascertain whether or not continued use of onsite systems in these areas would be technically feasible if centralized management and systematic upgrading of failing systems onsite were to be implemented. Regardless of the final wastewater management options selected for the respective "problem areas," implementation of an onsite management district is recommended for those residences that would not be served by centralized alternatives.

Private Systems -- Two wastewater treatment facilities, the Tee Kay lagoon and the Martell lagoon, serve isolated communities in the South Plant service area. Interceptors are not yet available because of high costs related to low population density. As the population grows, interceptors would be extended to these outlying areas, and the facilities plan recommends that these lagoons should be eliminated. Meanwhile, strict enforcement of NPDES permits should reduce the impact that these lagoons may have on water quality in the planning area.

Small Systems Outside the Planning Area -- The facilities plan indicates that pollution to upper Dardenne Creek by small treatment plants located just outside the planning area could be reduced by strict enforcement of NPDES permits conditions. The Weldon Spring Elementary School and Safari Campground each have treatment plants that may affect Dardenne Creek water quality. Eventually, these areas should be eliminated as interceptors are constructed.

Financing Requirements and Arrangements

The Duckett Creek Sewer District, the City of St. Charles, the City of St. Peters, and the City of Portage des Sioux each have the legal authority and financial resources to construct, operate, and maintain the proposed facilities for their respective jurisdictions, if approved and adequately funded by the responsible state and Federal agencies.

To be eligible for EPA or State construction grants, communities in the Mississippi River floodplain must become part of a sewer district, must incorporate, or must have a legal authority, such as a management agency, to act on their behalf. It is recommended that one of the existing sewer agencies or the St. Charles County Regional Sewer District become the management agency for the floodplain communities, including Peruque, Kampville, and South Shore. Each local agency would be responsible for any grant applications and administration of the design and construction of grant eligible improvements under the EPA Construction Grants Program or State Grant Program. Each would also be responsible for the operation and maintenance of its systems.

The proposed construction projects in the Duckett Creek facilities planning area are eligible for Federal construction grants assistance. The grant-eligible items include pumping stations, interceptor sewers, force mains, treatment units, and sludge disposal facilities. After 30 September 1984, these items qualify for 55% Federal funding for conventional projects. Projects proposing use of innovative and alternative technology are eligible for an additional 20% Federal share, or a total of 75% Federal funding.

The Missouri Clean Water Commission has a program to provide additional construction grant funds equal to a 25% share after 30 September 1984. For innovative and alternative projects, the State grant share after 30 September 1984 is 15%. These funds apply to the same eligible items as the Federal grant. In addition, the Missouri Clean Water Commission administers a new State construction grant program where Federal funding is not involved. This program allows the State to make 55% grants to communities for wastewater facilities. The grant amount is limited to $500,000 per year for communities with a service area of less than 500,000 persons.

The amount of Federal and state monies available to fund the construction grants program is quite limited relative to the number of projects for which assistance is sought. To ensure that the available money is spent on the most serious water quality problems, the State of Missouri maintains a priority list which ranks the projects seeking funding on a variety of factors, including water quality problems, population affected, public health hazards, and others. Because of the many projects throughout the state attempting to obtain Federal and state funding, and the reduced levels of funding currently available, some of the projects recommended for implementation in the Duckett Creek Facility Planning Area may not be able to obtain Federal or state grant assistance.

Consumer Cost

January, 1984 user charges for residential customers of the three major sewer agencies are summarized below. Future costs are dependent upon the amount of improvements necessary for adequate wastewater treatment and the population growth of each service area. Preliminary calculations for user charges are also presented below.

Sewer Authority	Estimated current annual user charge*	Estimated future annual user charge	
		1985	2005
Duckett Creek Sewer District	$94	$120	$116
City of St. Charles	$94	$ 96	$ 80
City of St. Peters	$89	$ 50	$ 79

Estimated future user charges are calculated for design years 1985 and 2005. Calculations for 1985 include debt service for only those projects under way during 1985. Calculations for 2005 include all projects. Annual debt service pays the local capital cost of improvements and is based on an annual interest rate of 10% for a 20-year payment period. Annual O&M costs include the cost to run the existing and proposed facilities as well as existing debt service. The annual user charge is calculated by dividing the total annual cost by the projected number of users.

ENVIRONMENTAL CONSEQUENCES

The most significant potential environmental consequences of the wastewater management alternatives are summarized in the following paragraphs. The reader is referred to Section 4.0 of this Draft EIS for a more thorough and detailed discussion of environmental consequences. The environmental effects of the alternatives are classified as either primary or secondary impacts. Primary impacts result directly from the construction and/or operation of the proposed project. Short-term primary impacts generally occur during construction. Long-term primary impacts occur throughout the life of the project and generally result from the operation of the proposed facilities. Secondary impacts are the indirect effects of the project, and occur principally from changes in population and land use that induce further actions or effects. For example, improved or expanded wastewater treatment systems can make land available for urban development that otherwise would not have been available. This induced residential, commercial, or industrial development could create an increased demand for other public facilities and services; increase development pressure on agricultural lands, woodlands, or other environmentally sensitive areas; increase ambient noise levels; lead to air and water pollution; or displace low and moderate income families. Secondary or indirect impacts also may be either short-term or long-term. Short-term secondary impacts, for example, would include the disruption of the environment that occurs during the construction of the support developments that are induced by the proposed project. An example of a long-term secondary impact would be the urban runoff that occurs following the induced development of agricultural land or open space areas.

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* Based on water meter readings equivalent to three persons per household at 75 gallons per capita per day, 365 days per year.

Primary Impacts of No Action Alternative

Potentially significant environmental impacts of the No Action Alternative result from the continued use of existing wastewater treatment facilities that are currently overloaded and inadequate. These systems include failing onsite systems and several centralized wastewater treatment plants.

Existing wastewater treatment and transmission facilities that are currently overloaded would receive additional wastewater in the future due to anticipated population growth in sewered areas. Consequently, current stream discharges of untreated or partially treated sewage would increase. Existing stream water quality degradation resulting from inadequate wastewater treatment would become more acute. Although water quality would become more degraded, its effect on many of the organisms that inhabit tributaries of the Missouri and Mississippi rivers would be minimal, since most of these organisms are already pollution-tolerant. However, adverse effects on aquatic biota may occur farther downstream in the Missouri and Mississippi rivers as water quality degradation increases in the tributary streams.

In certain locations in the planning area, onsite wastewater management systems have been failing due to the poor hydraulic characteristics of the soil. If the existing centralized collection and treatment facilities are not expanded, it is likely that as additional development occurs in unsewered areas, additional onsite systems will be installed where soil characteristics are unfavorable. Consequently, the number of onsite system failures would be expected to increase under the No Action Alternative. These failures result in the surfacing of partially treated sewage, thereby creating a health hazard due to the potential for human contact with water containing pathogenic (disease-causing) organisms.

The potential for groundwater contamination also would continue to exist and would increase in floodplain areas as a result of failing onsite systems resulting from soil limitations and high water tables. These failing septic systems, in the presence of alluvial aquifer wells, create the potential for a health hazard. At present, this potential is slight, but continued use of existing alluvial wells and increased pumping due to population growth could increase health risks. Similar potential problems exist in upland portions of the planning area that are unsewered and have failing onsite septic systems. Where soils are not suitable for onsite systems, untreated or partially treated wastewater is discharged to streams or land surfaces, thereby creating a potential health risk.

Secondary Impacts of the No Action Alternative

St. Charles County is an area that has undergone significant and rapid population growth in recent years. This growth pattern, although it has slowed somewhat, is anticipated to continue. Some of the wastewater treatment facilities in the planning area currently have difficulties in meeting the effluent limitations specified by their NPDES permits because of hydraulic overloads, system deterioration, and related factors. In addition, some portions of the county currently served by onsite wastewater treatment systems are not providing an adequate level of treatment to safeguard public health. Consequently, as population density in the area increases, these problems would worsen. Non-point source pollution would increase as a result of new development and this would further contribute to the degradation of surface water quality. Without expansion of the centralized wastewater treatment and collection systems, growth in the planning area would be inhibited and/or would tend to be less orderly and more dispersed.

Primary Impacts of Action Alternatives

The primary impacts of the four action alternatives are similar. These impacts would result from construction, operation, and fiscal requirements of these alternatives.

Construction Impacts -- Construction impacts are primarily related to land-disturbing activities, such as site clearing and excavation, that will occur at STP sites and along proposed sewer line collection and interceptor routes. Soil exposed during construction will be subjected to accelerated erosion until it is stabilized by revegetation or other means. Storm water runoff from construction sites will transport eroded soil into stream channels and drainageways where sedimentation will occur. Adverse impacts resulting from construction-related erosion and sedimentation include: nutrient and other pollutant inputs to streams; possible crop damage and interruption of agricultural activities; possible siltation, clogging of road culverts, and localized flooding where drainageways are filled with sediment; and damage to structures, roads, and ditches.

Increased sedimentation resulting from facilities construction could degrade surface water quality. Adverse surface water quality impacts would include increased nutrient inputs, increased turbidity, and siltation, and would occur under all action alternatives. However, these impacts would vary in magnitude and duration depending on the extent of rainfall during construction, the length of the sewer lines, the placement of lines in relation to drainageways, and the effectiveness of mitigation measures used to reduce runoff and sedimentation.

Adverse surface water quality impacts would likely result in a short-term decrease in aquatic productivity. However, severe erosion and sedimentation from sewer line construction are not expected since mitigation measures, such as sedimentation ponds and other erosion prevention techniques (hay, mats, etc.), will be required provisions in construction permits and grant awards. Therefore, adverse impacts on aquatic life are expected to be temporary and insignificant.

Construction activities would result in impacts to terrestrial biota to varying extents. Construction of interceptor lines would result in temporary losses of vegetated areas during initial earth moving operations. Disruption of backyard vegetation and the presence of construction equipment and noises would cause temporary displacement of most vertebrate species and mortality of a few of the smaller, less mobile species. Revegetation and cessation of construction activities would allow re-establishment of animals in disturbed areas. Animals most commonly displaced would be those associated with human habitation (e.g., eastern cottontail rabbits, house sparrows, starlings, etc.). Most of these animals would relocate in adjacent habitats.

Proposed sewers and force mains generally would be located parallel to and contiguous with existing road rights-of-way and stream corridors. A strip of approximately 20 feet of roadside vegetation would be removed during sewer line construction along county road rights-of-way, and a strip of approximately 20 to 40 feet would be disrupted for placement of force mains. This could disrupt hedgerow/fencerow vegetation and associated animal life in both residential and agricultural portions of the planning area.

The dominant land cover types along the proposed wastewater collection lines are residential, commercial, and agricultural. Small woodlots border the collection line routes at scattered locations; second-growth roadside shrub vegetation would likely be destroyed. Most birds, mammals, reptiles, and amphibians that reside on or near the proposed collection line routes are expected to relocate in adjacent areas during construction, however, less mobile animals would incur some mortality from construction.

All construction activities in the Mississippi River floodplain should be planned and conducted to prevent disruption of migratory waterfowl feeding, resting, and roosting areas. The major migratory periods occur from August through December and during March and April.

Expansion of existing STPs under all action alternatives would not require purchase of additional land outside present plant boundaries. Construction of new facilities at the plants is not expected to affect or change existing land use in the immediate vicinity of the STPs. It is possible, however, that current land use and certain future land uses potentially could be affected, to an unknown extent, by increasing treatment capacities or abandoning existing treatment facilities.

Proposed interceptor line routes which are parallel to stream courses and/or road rights-of-way are predominantly in areas currently used for agriculture or low density residential development. Construction impacts would include crop damage, disruption of farm operations, and compacting of soils during construction and backfilling activities.

Truck traffic associated with the construction of wastewater collection and treatment systems would increase traffic congestion and disrupt local traffic patterns, particularly in urban areas. Temporary road closures during excavation, grading, and backfilling along roadways would modify vehicular traffic patterns and inconvenience motorists. The temporary closure of some roads also would inconvenience permanent residents and result in increased traffic congestion on adjacent roadways.

No known cultural resources would be affected by expansion of the existing STPs. Proposed rights-of-way for new sewer lines were examined for prehistoric, historic, and architectural resources. Three prehistoric sites and one multicomponent site were located within or adjacent to proposed interceptor line rights-of-way. Further testing would be necessary to determine their eligibility for nomination to the National Register of Historic Places. One of the historic structures present at the multicomponent site may be architecturally significant. Portions of two sites are within the 100-foot wide alignment. These areas may be directly impacted by construction activities.

Operation Impacts -- Operation impacts are primarily related to effects from the elimination or rehabilitation of failing onsite wastewater management systems and the discharge of higher quality wastewater treatment effluent from upgraded facilities to area streams. These activities are expected to improve stream and groundwater quality within the planning area.

In Dardenne Creek, current water quality standards for un-ionized ammonia-nitrogen and dissolved oxygen are being violated for several miles below both the Harvester-Dardenne and Spencer Creek STPs. Water quality data indicate that tributaries of Dardenne Creek are severely polluted due to wastewater effluent discharges from both STPs. Implementation of Alternatives 3, 6, 7, or 8 would remove the present discharge from the Harvester-Dardenne plant and thereby reduce the pollutant loadings to Dardenne Creek.

Water quality modeling of Spencer Creek and the lower Dardenne Creek has shown that when secondary treatment is employed (at the Spencer Creek STP) under worst-case drought conditions, the dissolved oxygen would be completely depleted in Dardenne Creek within 1 mile below the STP. There would also be a violation of the un-ionized ammonia standard below the Spencer Creek STP. The model also predicts a dissolved oxygen sag upstream of the Spencer Creek STP due to sediment oxygen demand and background loads which are significant under these low flow conditions.

Under all four action alternatives, dissolved oxygen and total suspended solids concentrations should improve in upper Dardenne Creek and lower Harvester Creek due to the closure of the Harvester-Dardenne STP since this would eliminate wastewater effluent currently discharged into Dardenne Creek. The expansion of the Duckett Creek STP as proposed in Alternatives 6, 7, and 8 would improve water quality downstream from the Duckett Creek facility. Upon completion of the plant modifications, the improved water quality conditions should result in an increased diversity and abundance of aquatic biota. These improvements should occur throughout the Dardenne Creek system as water quality improves as a result of more efficient wastewater collection systems for outlying residential areas that were previously dependent on small plants or onsite systems.

Land use within the rights-of-way of wastewater conveyance lines would be affected temporarily when maintenance or repairs are performed on sections of the sewer lines. Periodic excavation and filling also would disturb vegetation and soil along conveyance lines. The release of low-level odors and aerosols from STPs and the awareness that potentially hazardous and/or malodorous gases could be released from these plants, may adversely affect future land uses adjacent to the facilities.

Operations of existing and planned centralized wastewater treatment plants, sewer lines, and ancillary facilities should have minimal adverse impacts on groundwater resources in the planning area. Proper construction and operation procedures should minimize the potential for groundwater contamination due to spills or leakage of untreated or partially treated wastes. Primary dangers of groundwater contamination would be associated with leakage along sewer lines and around sewage lagoons, and leachate from sludge storage areas. Any sewer lines located in floodplain areas could pose potential problems unless properly constructed and maintained. Groundwater quality in floodplain areas and downstream from all existing treatment plants should improve under all action alternatives. Water quality in alluvial aquifers should remain high or improve with more effective wastewater treatment in the planning area.

The continued use of existing onsite systems and the future use of new onsite systems has the potential to cause groundwater contamination problems, especially in those localized areas developed in floodplains where individual alluvial wells are the source of potable water. New developments in these parts of the planning area should consider cluster systems, where suitable, and mound systems in areas of high water levels. Increasing development in floodplain areas and development of more water supply wells as potable water sources also could cause migration of contaminants from waste treatment areas to these wells.

Fiscal Impacts -- Implementation of the facility plan recommended alternative would not impose a significant financial burden on residents in the service areas. This is suggested by a high growth rate, relatively high income levels, a relatively young population which suggests fewer people on fixed incomes (6% of residents are over 65 years old in St. Charles County compared to the state percentage of 13.2%), and commercial growth in the area.

Secondary Impact of Action Alternatives

Within the facility planning area, factors other than the availability of centralized wastewater treatment are heavily influencing population growth. St. Charles County is currently experiencing significant population growth and urbanization due to a number of factors, including:

- Improved transportation access between the planning area and St. Louis;
- Existence of large amounts of vacant buildable land suitable for residential and commercial development;
- Pro-growth planning policies that serve to facilitate population growth; and
- Siting of major new employment centers in nearby areas.

Given these factors and recent trends in the demography and urbanization of the area, population growth appears to be an assumed condition and would not result only from the expansion of wastewater treatment facilities. Therefore, the four final action alternatives would have more impact on where growth may occur rather than on absolute population growth.

Land use impacts associated with any of the action alternatives are primarily related to changes from agricultural uses to urban uses, i.e., residential, commercial and/or industrial uses. Due to the availability of an expanded central collection system, growth would tend to concentrate or occur first in those areas where sewage services are available. Without development of any of the four final action alternatives, there would be more reliance on onsite systems for wastewater treatment. Therefore, development would be more likely to be dispersed. With a concentration of development in areas with sewer services, changes in land use and growth may be more orderly and impact less total land area.

RECOMMENDED MITIGATION MEASURES

As previously identified, various adverse impacts would be associated with the proposed action alternatives. Many of these adverse impacts must be reduced significantly by the application of mitigation measures. These measures consist of a variety of legal requirements, planning measures, and design practices. The extent to which these measures are applied will determine the ultimate impact of the particular action.

Mitigation of Construction Impacts

Anticipated construction-related impacts are primarily short-term effects resulting from land-disturbing activities at the STP sites or along the routes of proposed wastewater collection and conveyance lines. Specific mitigation measures recommended for reducing dust generation, subsidence, erosion, and sedimentation include:

- frequent street sweeping;
- prompt road repaving;
- prompt reseeding, landscaping, and restoration of vegetation;
- regrading and compacting of trenches to prevent subsidence;
- minimizing requirements for grading and excavation;
- removing topsoil and stockpiling it whenever possible before grading begins;
- appling appropriate structural or agronomic practices to control runoff and sedimentation during and after construction;
- developing stabilized drainage systems; and
- establishing a firm construction schedule that is coordinated with clearing and grading activities.

To minimize exhaust emissions and noise from construction equipment, proper equipment operation and maintenance procedures must be followed.

Construction-related disruption in the community should be minimized through considerate contractor scheduling and appropriate public announcements. State and County highway department regulations concerning roadway disruptions should be rigorously adhered to. Special care must be taken to minimize disruption of access to frequently visited establishments. Announcements should be published in local newspapers and broadcast from local radio stations to alert drivers of temporary traffic disruptions on primary routes. Street closing and blasting schedules also should be announced by flyers delivered to each affected household, or by another appropriate technique.

To avoid or minimize damage to roadways, planning routes for heavy construction equipment and materials must ensure that surface load restrictions are considered. Trucks hauling excavation spoil to disposal sites or fill material to the STP sites should be routed along primary arterials to minimize the threat to public safety and to reduce disturbance along residential streets.

Known archaeological sites located along proposed interceptor rights-of-way have been inventoried by pedestrian survey. Two sites, located partially within the construction corridors, should be avoided. If it is not possible to avoid these sites, subsurface testing would be necessary to determine their eligibility for nomination to the National Register of Historic Places. If any additional cultural resources are found during construction, the State Historic Preservation Officer (SHPO) must be notified immediately.

Mitigation of Operation Impacts

Adverse impacts related to the operation of the proposed wastewater collection systems and treatment facilities should be minimal if the facilities are designed, operated, and maintained properly. Aerosols, gaseous emissions, and odors from the various treatment processes should be controlled through responsible operation and maintenance procedures. Above-ground pumps should be enclosed and installed to minimize sound impacts.

Special care to control chlorination and effluent concentrations of chlorine residuals should be taken at the Spencer Creek and Mississippi River STPs to minimize adverse impacts to the aquatic biota in receiving streams, since chlorination of wastewater can result in the formation of halogenated organic compounds that are potentially carcinogenic. Plans for chlorination systems should provide for continuous monitoring of chlorine residuals (with visual and audible alarms) to ensure that chlorine concentrations remain within design limits.

Operation impacts resulting from power failures could include sewer backups and localized flooding in the collection system; biological system upsets at the STP; stagnation of waters; and mechanical problems in the treatment facility. To mitigate the potential for such problems, secondary power sources are required to enhance system reliability.

Mitigation of Secondary Impacts

Some secondary impacts are expected to occur from implementation of any of the action alternatives. Adequate zoning, health, and water quality regulations and enforcement should minimize these impacts. Local growth management planning also would assist in regulating the general location, density, and type of growth that might occur, which would serve to minimize the potential for adverse impacts due to changes in population and land use.

UNAVOIDABLE ADVERSE IMPACTS

Some adverse impacts associated with implementation of the action alternatives cannot be avoided. The centralized collection and treatment system alternatives would have the following adverse impacts:

- Short-term construction dust, noise, and traffic disruptions;
- Alteration of vegetation and wildlife habitat along the sewer and force main corridors, and at the STP sites;
- Erosion and siltation during land-disturbing activities;
- Periodic odors associated with upgrading/conversion of wastewater and sludge handling facilities; and
- User fees for management and operation of wastewater treatment services for the residents within the proposed service areas.

IRRETRIEVABLE AND IRREVERSIBLE RESOURCE COMMITMENTS

The major resources that would be committed through the implementation of any of the action alternatives would include some or all of the following resources:

- Fossil fuel, electrical energy, and human labor for facilities construction and operation;
- Chemicals, especially chlorine, for STP operation;
- Tax dollars for construction and operation; and
- Some unsalvageable construction materials.

ALTERNATIVES AVAILABLE TO EPA

Two basic alternatives are available to EPA through the MDNR: (1) awarding of a construction grant to the Duckett Creek Sewer District, and (2) denial of a grant. Grant denial constitutes the No Action Alternative for EPA. Any funding would be limited to 55% of the eligible portion of the cost of constructing conventional treatment facilities and 75% of the eligible portion of the cost of constructing innovative/alternative technology facilities.

ALTERNATIVES AVAILABLE TO OTHER AGENCIES

The Missouri Department of Natural Resources (MDNR) also has two funding alternatives: (1) awarding of a construction grant to the Duckett Creek Sewer District, and (2) denial of a grant. In addition, the U.S. Army Corps of Engineers (USCOE) can issue or deny a Section 404 and/or a Section 10 permit for those project activities that would require a USCOE permit prior to construction.

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1.0 PURPOSE OF AND NEED FOR ACTION

1.1. Project History

The planning area addressed in this Environmental Impact Statement (EIS) is located in eastern St. Charles County in eastern Missouri approximately 25 miles west of St. Louis (Figure 1-1). The planning area is generally bounded by the Mississippi River on the north, State Highway 94 on the east, the Missouri River on the south, and US Highway 40 and County Highway C on the west. It includes the Upper Mississippi River -- Salt River Basin watersheds of Dardenne, Spencer, Sandtart, Cole and Boschert creeks, and the Lower Missouri River Basin watersheds of Duckett Creek and Taylor Branch. The planning area includes the cities of St. Charles and St. Peters, the Village of Portage des Sioux as well as unincorporated portions of St. Charles County.

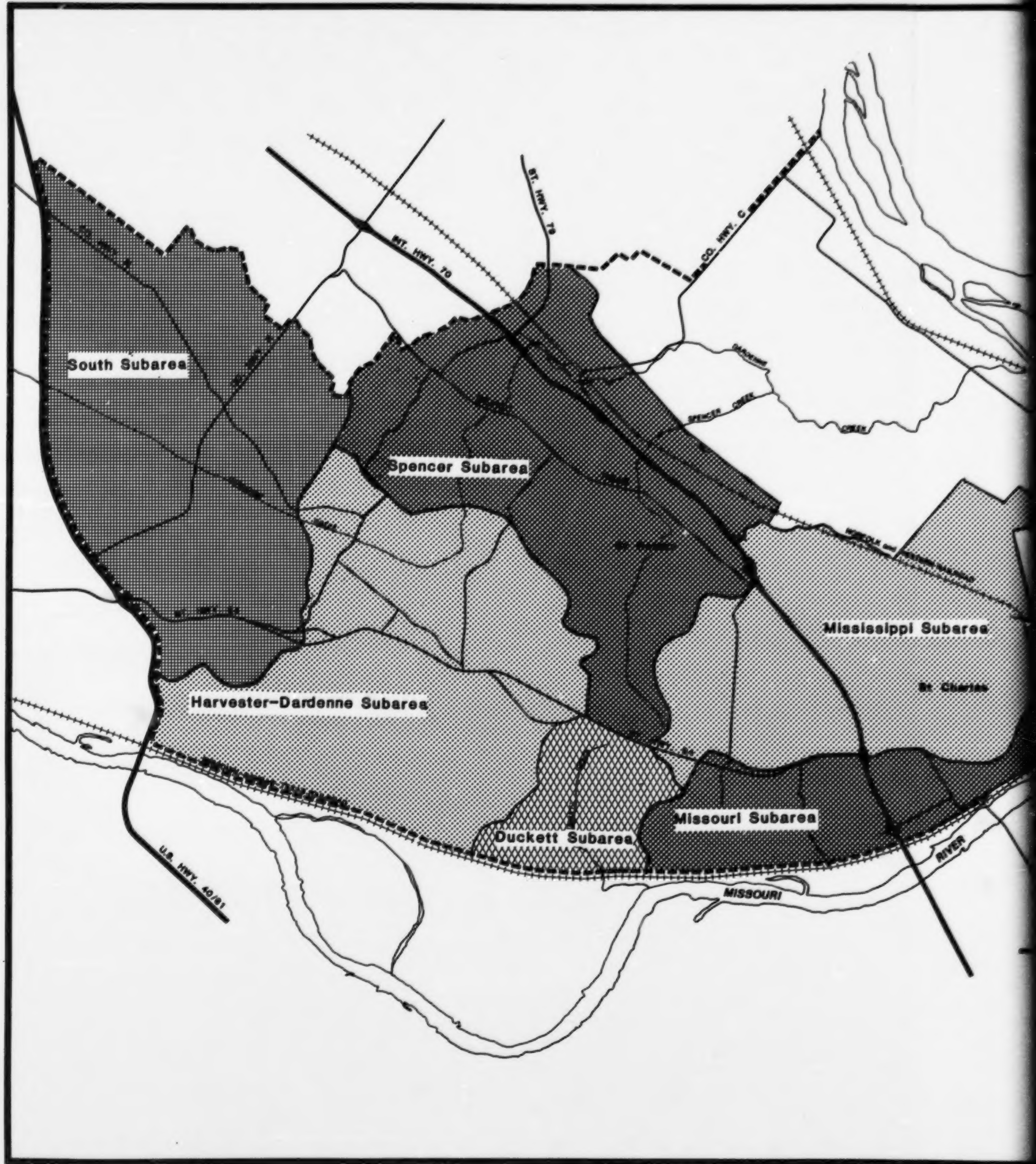
The planning area is located in the Dissected Till Plains section of the Central Lowland Physiographic Province. The northern portion of the planning area, i.e., north of the Norfolk and Western Railroad, constitutes a broad, generally level floodplain area of the Mississippi and Missouri rivers. The southern portion of the planning area contains gently rolling upland areas with dissected river valleys and includes almost all of the population of the planning area.

This portion of St. Charles County is currently experiencing significant population growth and urbanization due to a number of factors including:

- Improved transportation access between the planning area and St. Louis
- Existence of large amounts of vacant buildable land suitable for residential and commercial development
- Pro-growth planning policies to facilitate population growth
- Siting of major new employment centers in nearby areas.

The history of wastewater facilities planning in St. Charles County in the last 12 years is as follows:

1972 - St. Charles County voters created a countywide Regional Sewer District (RSD). The formation of a RSD was opposed by the cities of O'Fallon and St. Peters.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ST. HWY. 70
CO. HWY. C
South Subarea
Spencer Subarea
SPENCER CREEK
CREEK
Mississippi Subarea
St. Charles
Harvester-Dardenne Subarea
Duckett Subarea
Missouri Subarea
U.S. HWY. 40/61
MISSOURI
RIVER

1-2.a

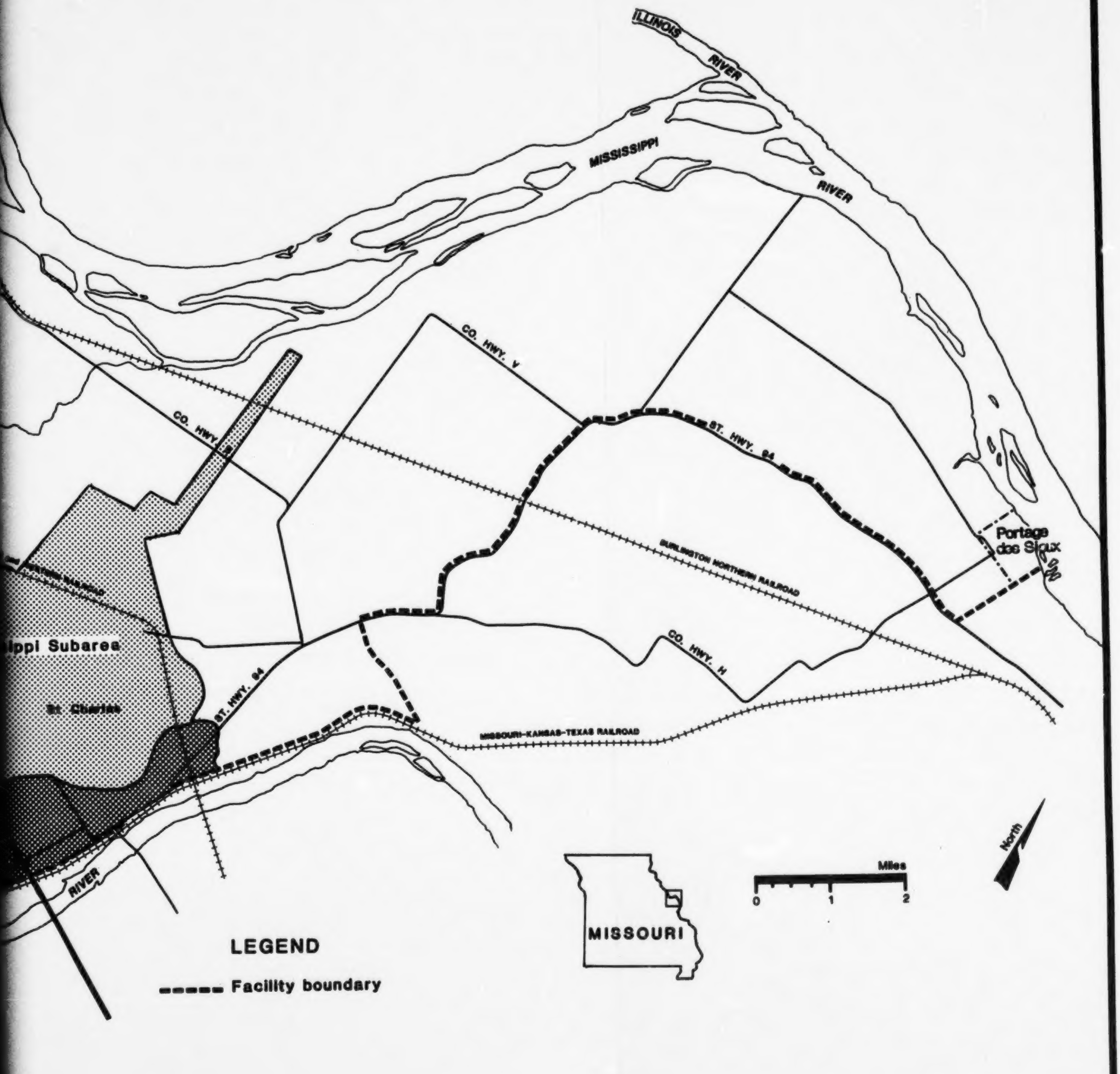

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
ippi Subarea
St. Charles
ST. HWY. 94
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
MISSOURI
Miles
0
1
2
North
LEGEND
▬ ▬ ▬ Facility boundary

Figure 1-1.
Location of Planning Area.

1976 - St. Charles County Voters defeated a county bond issue to financially support the RSD.

1978 - The Duckett Creek Sewer District came into existence as an operating entity following the purchase of two private treatment facilities.

1978 - The East-West Gateway Coordinating Council (EWGCC), the regional 208 planning agency, adopted a 208 plan which recommended a regional treatment system to serve O'Fallon, St. Peters, St. Charles, and the unincorporated areas between these communities.

1979 - The Missouri Clean Water Commission (CWC) reviewed and certified the EWGCC 208 plan. Strong opposition to this plan was expressed by O'Fallon, Lake St. Louis, and St. Peters as well as the St. Charles County Municipal League.

1979/ 1980 - Federal regulations require the Governor of Missouri to designate management agencies for implementing 208 plans. The EWGCC 208 plan did not, however, make any recommendations on management agencies. For this reason, the CWC ordered the local governments in St. Charles County to reach a consensus concerning management agencies by 1 January 1980. In response to this mandate, the local governments in St. Charles County banded together to form the St. Charles County Waste water Management Board (WMB). The WMB recommended to the CWC on 28 December 1979 the following management agencies for implementing wastewater facilities plans: (1) Wentzville; (2) O'Fallon/Lake St. Louis; and (3) Duckett Creek/St. Peters/St. Charles. The CWC endorsed this management strategy for St. Charles County, and transmitted this recommendation to the Governor.

April 1980 - The Governor certified the St. Charles County management agencies to the US Environmental Protection Agency (USEPA).

May 1980 - USEPA accepted the state's 208 certification, including management agencies to St. Charles County.

January 1981 - St. Peters, St. Charles, and the Duckett Creek Sewer District agreed upon a local consultant for preparing a facilities plan on the "eastern" subregional area.

July 1981 - A Step 1 planning grant was awarded by USEPA for the facilities plan with the Duckett Creek Sewer District serving as the lead agency.

December 1982 - USEPA determined that an EIS was required on the plan and issued a Notice of Intent to prepare an EIS.

At present, public wastewater treatment facilities are operated by St. Peters, St. Charles, Portage des Sioux, and the Duckett Creek Sewer District. In addition, there are several private and industrial wastewater treatment facilities in the planning area. A detailed discussion of the existing centralized collection and treatment systems in the planning area is contained in Section 2.1.

The primary impetus for facilities planning in the planning area is the high population growth which the area is experiencing. As additional growth occurs, improvements in wastewater collection and treatment capability and capacity will be necessary. In addition, some of the facilities in the planning area currently have difficulties in meeting the effluent limitations specified by their National Pollutant Discharge Elimination Systems (NPDES) permits because of hydraulic overloads, system deterioration, and related factors. Further, some portions of the planning area are currently served by onsite wastewater treatment systems which are not providing an adequate level of treatment to safeguard public health. Therefore, consideration must be given to upgrading inadequate onsite systems or providing centralized collection systems in these currently unsewered areas.

Facilities planning in the planning area was initiated in December 1981. The facilities planning consultant, Sverdrup & Parcel and Associates, Inc. developed eight (8) preliminary alternatives for the planning area for correcting existing pollution problems and for providing necessary improvements in wastewater collection and treatment capability and capacity. A Infiltration/Inflow (I/I) analysis also was performed. Following preliminary analysis of the eight preliminary alternatives, four (4) alternatives were selected for detailed engineering analysis on the basis of cost-effectiveness, probable environmental impact, implementability, and related factors. A more detailed discussion of the alternatives and the screening process used to eliminate preliminary alternatives from further analysis is contained in Section 2.4.

This EIS is being prepared concurrently with the facilities plan. Prior to the development of this Draft EIS, an Environmental Setting Report (USEPA 1983) was prepared which summarized the existing natural and manmade environment of the planning area. This report was used by the facilities planning consultant in the development of the preliminary alternatives and in the screening process used to identify alternatives suitable for in-depth evaluation. The Draft Facilities Plan (Sverdrup & Parcel and Associates, Inc. 1983b) was completed in November 1983 and has been reviewed by USEPA and the Missouri Department of Natural Resources (MDNR). Following this review, a Final Facilities Plan (Sverdrup & Parcel and Associates, Inc, 1984) was prepared and submitted during October 1984. The Final Facilities Plan addresses the comments provided by USEPA and MDNR on the Draft Facilities Plan; the final plan is currently undergoing agency review. This Draft EIS is based on information in the Final Facilities Plan and will be submitted for public and agency comment. Following the close of a 45-day comment period, a Final EIS will be prepared which identifies the action(s) which USEPA regards as most suitable, from an environmental, economic and legal standpoint, for ensuring that adequate wastewater treatment facilities will be available to safeguard public health and maintain and enhance water quality in the planning area.

1.2 Legal Basis For Action and Project Need

The National Environmental Policy Act of 1969 (NEPA) requires a Federal agency to prepare an EIS on "...major Federal actions significantly affecting the quality of the human environment..." In addition, the Council on Environmental Quality (CEQ) has established regulations (40 CFR Parts 1500-1508) to guide Federal agencies in determinations of whether or not Federal funds or Federal approvals would result in a project that would significantly affect the environment. USEPA has developed its own regulations (40 CFR Part 6) for the implementation of the EIS process. As noted above, USEPA Region VII has determined that pursuant to these regulations, an EIS is required for this facilities planning effort.

The Federal Water Pollution Control Act of 1972 (FWPCA, Public Law 92-500), as amended in 1977 by the Clean Water Act (CWA, Public Law 95-217) establishes a uniform, nationwide water pollution control program according to which all water quality programs operate. MDNR has been delegated the responsibility and authority to administer this program in Missouri, subject to the approval of USEPA. However, the authority for determining whether or not proposed actions are subject to NEPA is retained by USEPA.

Federal funding for wastewater treatment projects is provided under Section 201 of the FWPCA. The USEPA will fund 55% of the grant eligible costs for conventional wastewater treatment facilities. For innovative or alternative (I/A) treatment systems (e.g., septic tanks, and soil absorption systems), the funding level increases to 75% of the eligible costs. USEPA will not assist in funding land and easement costs, or costs associated with collection and transport of wastewater to the treatment facility. Similarily, the costs for alternative systems that the USEPA will not assist in funding are easement costs and collection system costs. The grant eligibility of the onsite portions of alternative systems varies depending on their ownership and management. Publicly and privately owned systems constructed after 27 December 1977, are not eligible for Federal grants. Collection systems could be eligible under the State's 20% discretionary funds category, but Missouri has not indicated plans to use this provision.

The dispersal of Federal funds to local applicants is made via the Municipal Wastewater Treatment Works Construction Grants Program administered by USEPA. Prior to the amendments of 1981, the program consisted of a three-step process: Step 1 included wastewater facilities planning; Step 2 involved the preparation of detailed engineering plans and specifications; and Step 3 covered construction for the wastewater management system.

The Municipal Wastewater Treatment Construction Grant Amendments of 1981 became law (Public Law 97-117) on 29 December 1981, and significantly changed the procedural and administrative aspects of the municipal construction grants program. The changes reflected in these amendments have been incorporated into Construction Grants-1985 (CG-85) Municipal Wastewater Treatment (July, 1984), and final regulations implementing the 1981 Amendments were issued by USEPA on 17 February 1984 (40 CFR 35, Subpart I). Under the 1981 Amendments, separate Federal grants are no longer provided for facilities planning and design of projects. However, the previous designation of these activities as Step 1 facilities planning, and Step 2 design, are retained in the CG-85. The term Step 3 grant refers to the project for which grant assistance will be awarded. The Step 3 grant assistance includes an allowance for planning (Step 1) and design (Step 2) activities, 50% of which may be requested at the time of the grant award (for a Step 3 grant), and the rest of which may be requested in the first payment after the grantee has awarded all prime subagreements, completed acquisition of all eligible land (if any), and received the Regional Administrator's (or delegated State's) approval for any force account work.

The CG-85 states that projects which received a Step 1 and/or Step 2 grant prior to the enactment of the 1981 Amendments should be completed in accordance with the terms and conditions of their grant agreement. Step 3 grant assistance will include an allowance for design of those projects which received a Step 1 grant prior to 29 December 1981.

Communities also may choose to construct wastewater treatment facilities without financial support from the state or Federal governments. In such cases, the only state and Federal requirements are that the design be technically sound and that the MDNR is satisfied that the facility will meet discharge standards. Any applicable local ordinances would still have to be met.

If a community chooses to construct a wastewater collection and treatment system with USEPA grant assistance, the project must meet all requirements of the Grants Program. The CWA stresses that the most cost-effective alternative be identified and selected. USEPA defines the cost-effective alternative as the one that will result in minimum total resource costs over the life of the project, as well as meet Federal, state, and local requirements. Non-monetary costs also must be considered, including social and environmental factors. The cost-effective alternative is not necessarily the lowest cost proposal. The analysis for choosing the cost-effective alternative is based on both the capital costs and the operation and maintenance costs for a 20-year period, although only the capital costs are funded. The selection of the most cost-effective alternative also must consider the social and environmental implications of the alternative. An alternative that has low monetary costs but significant environmental impacts would not be preferred over an alternative with higher monetary costs but lesser social and environmental impacts.

Missouri was required by the FWPCA (PL 92-500) to establish water quality standards for lakes and streams and effluent standards for discharge to them. Federal law stipulates that, at a minimum, discharges must meet secondary treatment requirements. In some cases, even stricter effluent standards are subject to USEPA approval and must conform to Federal guidelines.

A new wastewater treatment facility also is subject to the requirements of Section 402 of the FWPCA, which established the National Pollutant Discharge Elimination System (NPDES) permit program. Under the NPDES regulations, all wastewater discharges to surface waters require an NPDES permit and must meet the effluent standards identified in the permit. The USEPA has delegated the authority to establish effluent standards and to issue discharge permits to the MDNR. The USEPA, however, maintains review authority. Any permit proposed for issuance may be subject to a state hearing, if requested by another agency, the applicant, or other groups and individuals. A hearing on an NPDES permit provides the public with the opportunity to comment on a proposed discharge, including the location of the discharge and the level of treatment.

1.3 Study Process and Public Participation

Participants in the wastewater planning process during the past 2 years have included: the cities of St. Peters and St. Charles, the Village of Portage des Sioux, the Duckett Creek Sewer District, the state of Missouri, USEPA, Sverdrup & Parcel and Associates, Inc. (facilities planning consultant), WAPORA, Inc. (EIS consultant), and other Federal, state, local, and private agencies and organizations. A citizens advisory committee (CAC) composed of local officials, local residents, and representatives of a number of local interest groups was formed to provide input into the planning process and has met at key decision points during the project. In particular, the CAC provided valuable input into the selection of alternatives considered most suitable for detailed engineering analysis. A public hearing on the Draft Facilities Plan also was held on 15 February 1984. After this Draft EIS is printed, an additional public hearing will be held to discuss its conclusions and recommendations.

Major work efforts in the preparation of this Draft EIS took place during 1982 and 1983 and resulted in the preparation of an Environmental Setting Report in March 1983 and the preparation of this Draft EIS in late 1984. A modified version of the Environmental Setting Report appears as Chapter 3.0 of this document.

1.4 Issues

From USEPA's Notice of Intent to prepare an EIS, the Work Assignment to WAPORA, Inc., and the Facilities Plan, the following issues have been determined to be potentially significant and are addressed in this Draft EIS:

- Induced population growth which could result in concomitant impacts on:
    - floodplains
    - wetlands
    - hazardous areas
    - prime and unique agricultural areas
    - wildlife habitat areas
    - threatened and endangered species
    - historic and archaeological sites
- The effects of effluent discharges on the water quality of the Missouri and Mississippi rivers.
- The development of a user charge system acceptable to a population that is currently being served by numerous systems with varying user charges.
- The development of alternatives which satisfy the needs of numerous public and private entities with facilities that have widely ranging treatment capabilities, capacities, and design periods.
- The development of an equitable plan for compensating private utilities and public entities that have facilities which could be transferred to regional or subregional systems.
- Coordination between the public, EIS consultant, facilities planner, USEPA, MDNR, Duckett Creek Sewer District, cities of St. Charles and St. Peters, St. Charles County, and private utility companies.
- Construction impacts, including disruption of traffic flows with attendant impacts on land use, local businesses, and residents' commuting patterns.

2.0. DESCRIPTION AND EVALUATION OF WASTEWATER MANAGEMENT ALTERNATIVES

This chapter contains a description and evaluation of alternative systems for collecting, treating, and disposing of wastewaters generated in the Duckett Creek Facility Planning Area. The existing wastewater collection and treatment systems in the planning area are described in Section 2.1. The various wastewater management planning and design assumptions for the planning area as well as the wastewater management components considered in the facilities plan are discussed in Section 2.2. In Section 2.3, a thorough description of the alternative systems evaluated for handling wastewater in the Duckett Creek Facility Planning Area are presented. This section also contains a brief comparison of the final system alternatives in terms of cost effectiveness, non-monetary factors, and implementability. Finally in Section 2.3, the recommended facilities plan alternative is described. In Sections 2.4 and 2.5, the alternatives available to EPA and other agencies are identified, respectively.

Much of the information contained in this chapter was summarized from the Draft and Final 201 Facility Plans prepared by Sverdrup & Parcel, the facilities planning consultant to the Duckett Creek Sewer District, the City of St. Charles, and the City of St. Peters. Many of the conclusions and recommendations presented in the 201 Facility Plan resulted from active participation and planning by the Duckett Creek Citizens Advisory Committee. Although uncertainties still exist in the facilities plan, this EIS has made a deliberate effort to identify and qualify those aspects of the proposed project that remain indefinite.

2.1. Existing Wastewater Collection and Treatment Systems

Centralized as well as onsite wastewater collection systems are presently being utilized in the Duckett Creek Facility Planning Area; however, most of the sewage is collected and treated by centralized systems. A majority of the communities in the planning area have a centralized collection system(s) or jointly share a system with a neighboring community(ies). Other private collection systems are used primarily in rural areas where the population density is too low to warrant construction of sewers.

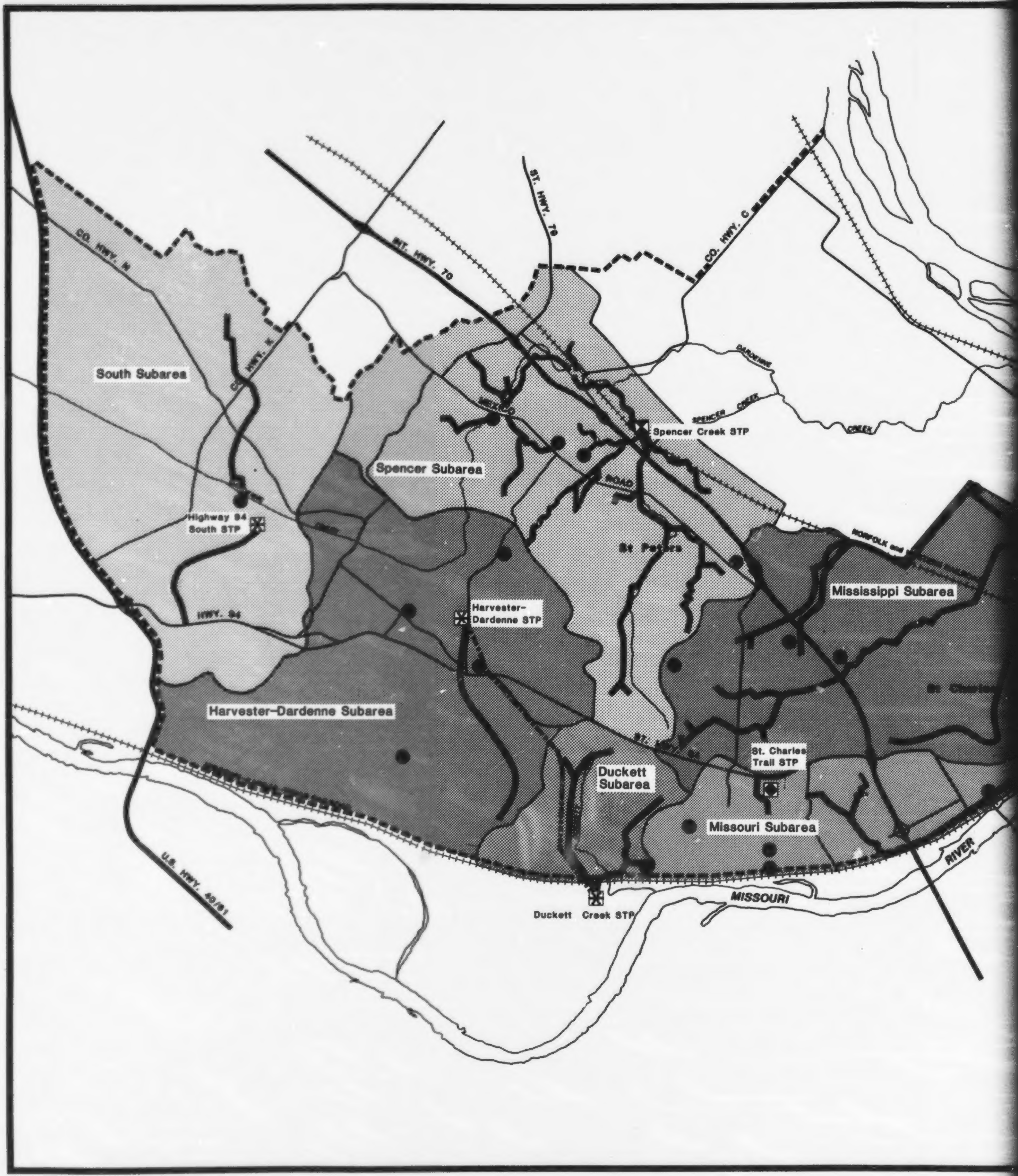
The Duckett Creek Facility Planning Area is located in eastern St. Charles County (Figure 1-1). The population of the planning area was estimated at 103,400 in 1983 and is projected to be 193,700 by year 2005. The planning area includes the Upper Mississippi River--Salt River Basin watersheds of Dardenne, Spencer, Sandfort, Cole, and Boschert creeks and the Lower Missouri River Basin watersheds of Duckett Creek and Taylor Branch, along with the City of St. Charles' Missouri River Service Area.

Approximately 56% of the 96,000-acre planning area is under the jurisdiction of three sewer authorities: the Duckett Creek Sewer District, the City of St. Charles, and the City of St. Peters. Portage des Sioux maintains a separate sewer system. Most of the heavily populated areas of the planning area are sewered, with the exception of a few subdivisions. Rural residents and isolated communities predominantly use septic tanks. Much of the planning area is undevelopable floodplain (see unshaded portions of Figure 2-1) under the provisions of Executive Order 11988 which restricts development in floodplain areas. Detailed discussions of planning area land use, soil types, and geological data are presented in Section 3.0 of this Environmental Impact Statement.

Wastewater generated in the planning area is primarily domestic sewage although there are some industrial and commercial discharges. Currently, there are 16 domestic sewage treatment facilities and six industrial facilities. The industrial discharges include filter backwash water and lime sludge lagoon decant from three water treatment plants; cooling water, floor and sink drains washwater, steam condensate, and boiler blowdown from an organic chemical manufacturer; cooling water from a metal casting operation; and truck washdown water from a concrete plant. Due to the small flows involved, these discharges are not expected to have a significant effect on water quality in the planning area. The locations of the existing municipal and private wastewater treatment facilities are shown in Figures 2-1 and 2-2, respectively. Summary information pertaining to each plant is provided in Table 2-1.

2.1.1. Centralized Wastewater Collection and Treatment Systems

There are five separate wastewater collection and treatment system authorities in the Duckett Creek Facility Planning Area. They are as follows; the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DARDENNE
SPENCER CREEK
CREEK
MEXICO
ROAD
South Subarea
Spencer Subarea
Spencer Creek STP
Highway 94 South STP
St Peters
NORFOLK and
Mississippi Subarea
HWY. 94
Harvester-Dardenne STP
St Charle
Harvester-Dardenne Subarea
ST. HWY. 94
St. Charles Trail STP
Duckett Subarea
Missouri Subarea
U.S. HWY. 40/61
RIVER
MISSOURI
Duckett Creek STP

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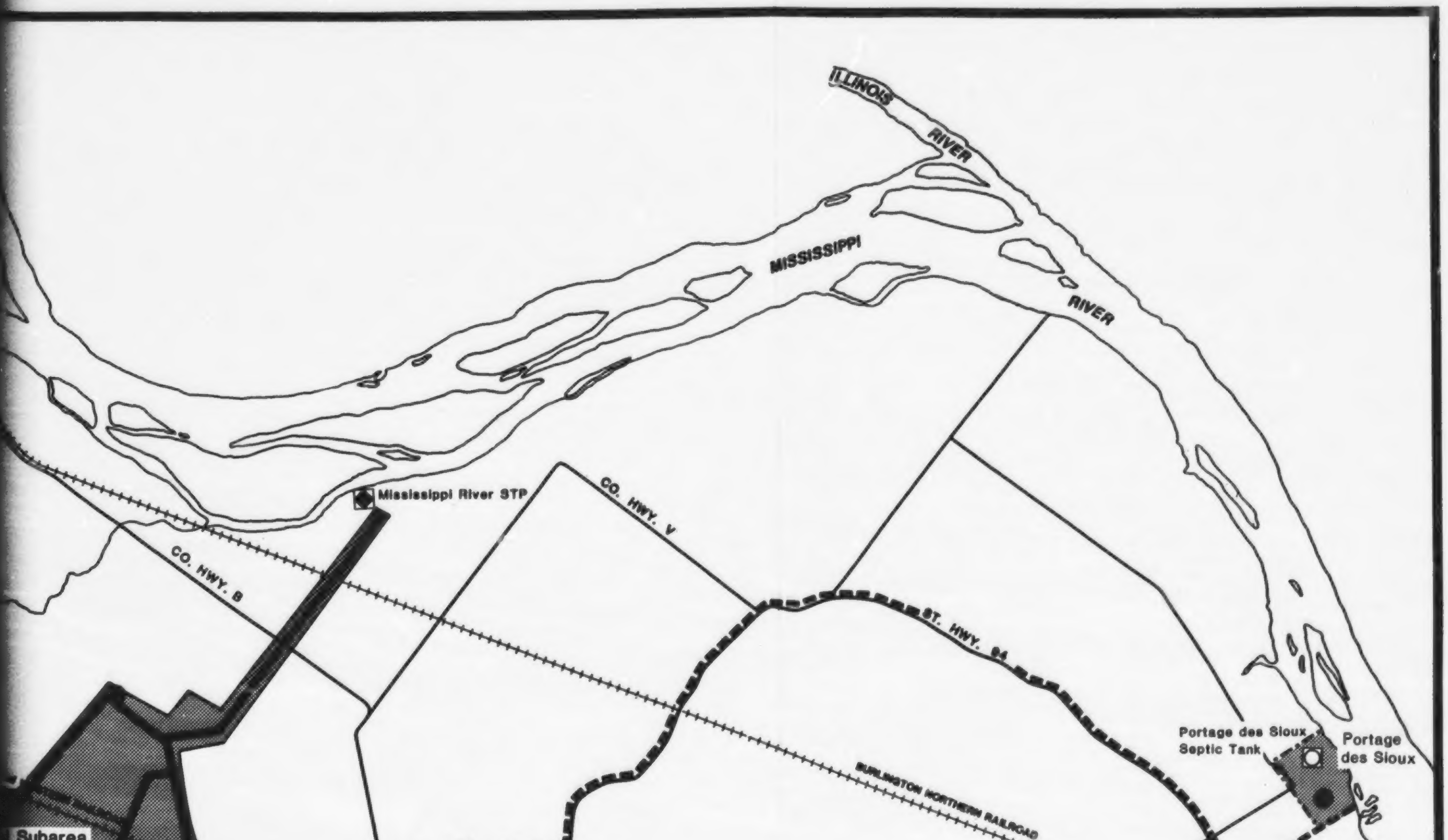
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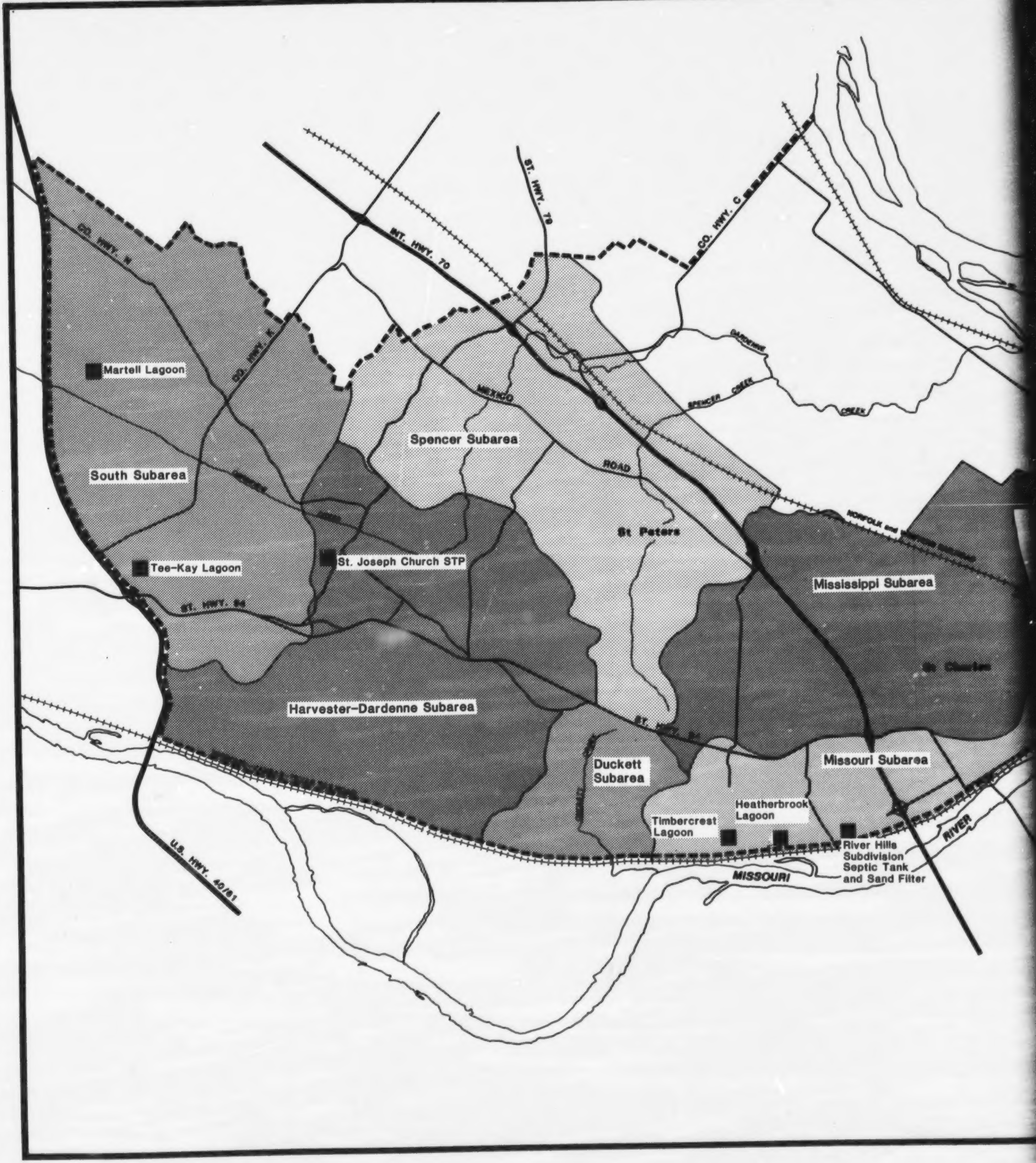
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY. B
ST. HWY 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux Septic Tank
Portage des Sioux
Subarea
St. Charles
ST. HWY 94
Boschertown Lagoon
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Pump station
Interceptor sewer
Interceptor/Force main currently under construction
Treatment plant by sewer authority
City of St. Charles
City of St. Peters
Portage des Souix
Duckett Creek Sewer District

Figure 2-1.

Existing Municipal Wastewater Facilities.


CO. HWY. N
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ST. HWY. 70
ST. HWY. 79
CO. HWY. C
Martell Lagoon
South Subarea
Tee-Kay Lagoon
ST. HWY. 94
St. Joseph Church STP
Spencer Subarea
MEXICO
ROAD
St Peters
SPENCER CREEK
CREEK
NORFOLK and WESTERN RAILROAD
Mississippi Subarea
St Charles
Harvester-Dardenne Subarea
ST. HWY. 94
Duckett Subarea
Missouri Subarea
Heatherbrook Lagoon
Timbercrest Lagoon
River Hills Subdivision Septic Tank and Sand Filter
MISSOURI
RIVER
U.S. HWY. 40/61

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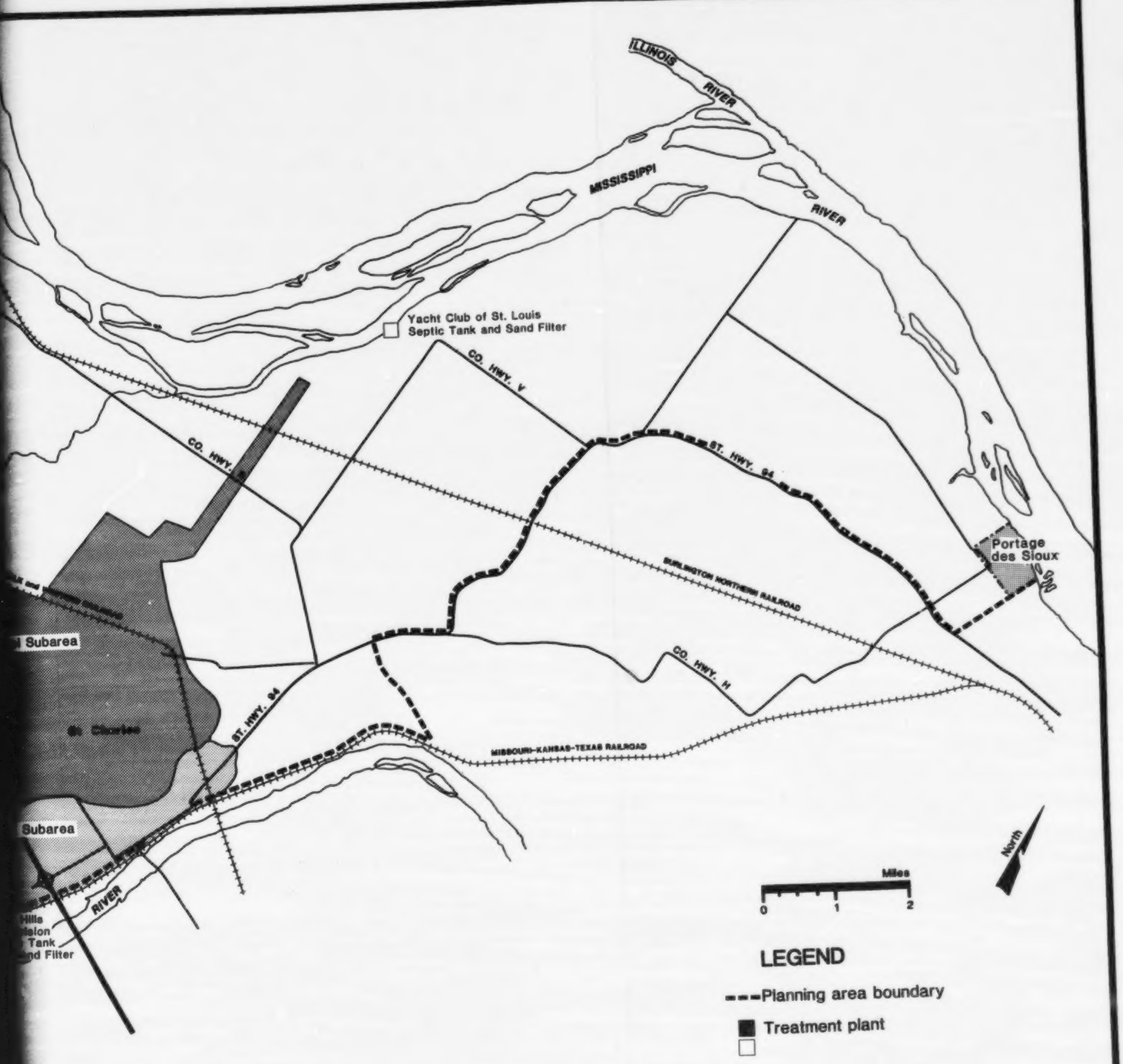
ILLINOIS RIVER
MISSISSIPPI RIVER
Yacht Club of St. Louis Septic Tank and Sand Filter
CO. HWY. V
CO. HWY. B
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
Subarea
St. Charles
Subarea
RIVER
Hills
ision
Tank
and Filter
North
Miles
0
1
2
LEGEND
Planning area boundary
Treatment plant

Figure 2-2.
Existing Private
Wastewater Facilities.

TABLE 2.1. SUMMARY DATA FOR EXISTING TREATMENT FACILITIES IN THE DUCKETT CREEK PLANNING AREA*

	Facility	Average Daily Flow (gpd)	Type of Facility	Receiving Stream	BOD_5/TSS Limits (mg/l)
(1)	City of St. Charles, Mississippi River STP	4,100,000	Tertiary treatment, including activated carbon adsorption	Mississippi R.	30/30 (Daily)
(2)	City of Portage des Sioux	16,700	Septic tank	Mississippi R.	30/30 (Daily)
(3)	Yacht Club of St. Louis	1,400	Septic tank/sand filter	Mississippi R.	permit pending
(4)	Duckett Creek Sewer District, Boschertown Lagoon	167,000	2-cell lagoon	Missouri R.	30/60 (Monthly)
(5)	Riverview Hills Subdivision	2,300	Septic tank/sand filter	Missouri R.	30/30 (Daily)
(6)	City of St. Charles, Missouri River STP	3,200,000	Primary treatment	Missouri R.	30/30 (Daily)
(7)	City of St. Charles, Heatherbrook Lagoon	20,000	1-cell lagoon	Missouri R.	30/60 (Monthly)
(8)	Duckett Creek Sewer District, Harvester-Dardenne STP	890,000	Contact stabilization	Dardenne Cr.	30/30 (Monthly)
(9)	Duckett Creek Sewer District, Highway 94 South STP	6,890	Contact stabilization	Dardenne Cr.	30/30 (Daily)
(10)	Martell Subdivision	13,000	2-cell lagoon	Dardenne Cr.	30/30 (Daily)
(11)	St. Joseph Church and School	10,000	Extended aeration	Dardenne Cr.	30/30 (Daily)
(12)	Duckett Creek Sewer District, Duckett Creek STP	536,000	Contact stabilization	Duckett Cr.	30/30 (Daily)
(13)	City of St. Peters, Spencer Creek STP	1,720,000	Extended aeration	Spencer Cr.	30/30 (Weekly)
(14)	City of St. Charles, St. Charles Trails STP	30,000	Extended aeration	Taylorbrook Cr.	30/30 (Monthly)
(15)	Timbercrest Subdivision	5,600	1-cell lagoon	Taylorbrook Cr.	no permit
(16)	Tee Kay Mobile Manor	10,900	1-cell lagoon	Schote Cr.	30/30 (Daily)

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* Information from NPDES monitoring reports on file with the Missouri Department of Natural Resources

Duckett Creek Sewer District, the City of St. Charles sewer system; the City of St. Peters sewer system; the City of Portage des Sioux sewer system; and the private wastewater collection and treatment systems.

Approximately 11 million gallons per day (mgd) of wastewater are treated at 16 treatment facilities by the four major sewering authorities. However, five of these treatment facilities treat 96% (10.6 mgd) of the wastewater. These five major treatment plants are the Duckett Creek Plant, Harvester-Dardenne Plant, Mississippi River Plant, Missouri River Plant, and Spencer Creek Plant. All the facilities are publicly owned treatment works (POTW) that maintain records suitable for evaluating infiltration and inflow. Each of the four major sewering authorities have associated collection and pumping stations.

There are 26 pumping stations within the wastewater collection systems in the Duckett Creek Facility Planning Area, and another 11 influent or effluent pumping stations at the treatment plants. The name, type, and capacity of each collection system, treatment plant, and pumping stations are presented in Tables 2-2 and 2-3, respectively. Most of the smaller pumping stations serve subdivisions or mobile home parks. The majority of these stations use submersible pumps. Many of the smaller stations would be eliminated once interceptor sewers are constructed.

The four major wastewater service authorities maintain their sewers. Interceptor lines range in age from new to over 20 years old. The 11 mgd of wastewater in the system originates from two major sources--sanitary wastewater from residences and commercial, industrial, and institutional establishments; and extraneous clear water-infiltration and inflow. The sanitary sewage volume (theoretical flow) was estimated from potable water consumption, while actual sewage volume was calculated from the records of the five largest treatment plants and an Infiltration and Inflow (I/I) analysis for Portage des Sioux.

Data relative to the performance of the major existing wastewater treatment facilities in the planning area are given in Table 2-4. Based on averaged data from discharge monitoring reports for the period from October 1981 through September 1981, 9 of the 16 wastewater treatment facilities are pres-

TABLE 2-2
COLLECTION SYSTEM PUMPING STATIONS*

Pumping Station	Type	Capacity (gpm)
• Duckett Creek Sewer District		
Parkwood	Sub	600
Timberwood	Sub	525
Harvest Acres	Sub	-
Briargate	Sub	-
Heritage	Sub	-
Trails of Riverwood	Sub	80
Riverview Drive	Sub	75
Bedford Mobile Park	W/D	-
Princess Jodi Mobile Park	Sub	-
Hutchins Metals	Sub	-
• City of St. Charles		
San Miguel Apartments	Sub	100
Sunnydale Mobile Park	Sub	300
Heatherbrook No. 1	Sub	500
Heatherbrook No. 2	Sub	200
Adams Street	W/D	2 x 1,900
Sandfort Creek	W/D	2 x 1,500
Marina Apartments	Sub	200
• City of St. Peters		
St. Peters Dardenne Creek	Scr	3,000
Old Towne	W/D	450
Country Hill No. 1	W/D	300
Country Hill No. 2	Sub	-
Venture Store	W/D	400
Missouri Cities Dardenne Creek	W/D	800
Hermitage	Sub	245
• City of Portage des Sioux		
Portage des Sioux No. 1	Sub	-
Portage des Sioux No. 2	W/D	-

Notes: Scr Screw
W/D Wet well/dry well
Sub Submersible
- Data not available

* See Figure 2-1 for locations of pumping stations

Source: Sverdrup & Parcel and Associates, Inc. (1983b)

TABLE 2-3
TREATMENT PLANT PUMPING STATIONS*

Pumping Station	Influent (I) Effluent (E)	Type	Capacity (gpm)
Mississippi River Plant	I	W/D	6,500
Missouri River Plant	I	W/D	3,600
Spencer Creek Plant, No. 1	I	Scr	2 x 3,000
Spencer Creek Plant, No. 2	I	Scr	3,000
Harvester-Dardenne Plant	I	W/D	875
Duckett Creek Plant	I	W/D	725
Hwy 94-South Plant	I	Sub	-
Hwy 94-South Plant	E	Sub	-
Boschertown Lagoon	I	W/D	700
Boschertown Lagoon	I	Sub	2 x
Boschertown Lagoon	E	W/D	2 x 420

Notes:		
	Scr	Screw
	W/D	Wet well/dry well
	Sub	Submersible
	-	Data not available

* See Figure 2-1 for locations of treatment plants and pumping stations

Source: Sverdrup & Parcel and Associates, Inc. (1983b)

TABLE 2-4
PERFORMANCE OF EXISTING TREATMENT FACILITIES*

Plant	Monitoring Period	BOD (mg/l)	Suspended Solids (mg/l)	BOD/TSS Effluent Limits (mg/l
Duckett Creek Sewer District Duckett Creek Sewage Treatment Plant	10/81-9/82	26	28	30/30
Duckett Creek Sewer District Harvester-Dardenne Sewage Treatment Plant	10/81-9/82	35**	32**	30/30
Duckett Creek Sewer District Highway 94 South Sewage Treatment Plant	NO DATA			
Duckett Creek Sewer District Boschertown Lagoon	10/81-9/82	36**	44	30/60
City of St. Charles Mississippi River Sewage Treatment Plant	10/81-9/82	12	9	30/30
City of St. Charles Missouri River Sewage Treatment Plant	10/81-9/82	97**	67**	30/30
City of St. Charles Heatherbrook Lagoon	10/81-9/82	47**	80**	30/60
City of St. Charles St. Charles Trails Sewage Treatment Plant	10/81-9/82	27	66**	30/30
City of St. Peters Spencer Creek Sewage Treatment Plant	1/82-10/82	16	46**	30/30
City of Portage des Sioux Septic Tank	10/81-9/82	85**	117**	30/30
Private Systems				
Riverview Hills Subdivision	1/81-12/81	12	332**	30/30
Martell Subdivision	NO DATA	-	-	30/30
St. Joseph Church & School	NO DATA	-	-	30/30
Timbercrest Subdivision	NO DATA	-	-	-
Yacht Club of St. Louis	NO DATA	-	-	-
Tee Kay Mobile Manor	10/81-6/82	60**	91**	30/30

* Information is based on averaged data from NPDES discharge monitoring reports on file with the Missouri Department of Natural Resources

** Exceeds facility's NPDES permit

Source: Sverdrup & Parcel and Associates, Inc. (1983b)

ently exceeding NPDES permit limitations. Monitoring reports were not available for two of the facilities in 1982, permits had expired for six others, and no discharge permit exists for one facility. Wastewater treatment plants in the system are not meeting NPDES permit requirements with regularity, and as a result water quality in the receiving streams is being degraded.

The overall collection systems for the planning area have been summarized as well as the bases for the existing flows, which treatment facilities are involved, and how the major facilities have performed historically. In the remainder of this chapter, the components of each of the wastewater collection and treatment system are described. The theoretical wastewater flows for each of the major systems are presented and the treatment facilities that treat these wastewater flows are summarized.

2.1.1.1. Duckett Creek Sewer District

Collection

The Duckett Creek Sewer District has approximately 520,000 linear feet of gravity sewer pipe ranging from 8 to 30 inches in diameter. Most of the smaller pipes are made of vitrified clay. Reinforced concrete is typically used for larger pipe. The Amarillo interceptor, constructed in 1982, is made of polyvinyl chloride (PVC) pipe.

Theoretical Flow

The theoretical wastewater flows for the four Duckett Creek service areas were estimated from typical unit contribution developed by Missouri Cities Water Company. The calculations and results are tabulated below.

Service Area	Number of Customers	Typical Flow Gallons per Customer/Month	Theoretical Flow		
			Million Gal/Month	mgd	gpcd
Boschertown	937	6,200	5.809	0.19	70
Duckett Creek	2,069	6,200	12.828	0.43	70
Harvester-Dardenne	3,448	6,200	21.378	0.71	70
South	34	6,200	0.211	0.007	70

Treatment

The Duckett Creek Sewer District operates and maintains four wastewater treatment plants and 16 lift stations (seven located at plant sites) with a staff of eight people, two of whom are certified operators.

In general, the plants and lift stations appear to be well maintained and all equipment is operational, although the age and capacity of some of the equipment are unknown. The chief operator has reported frequent problems with equipment failures except for one pump station in the Princess Jodi Mobile Park. The Harvester-Dardenne Plant has one full-time operator, and other lift stations and treatment plants are inspected at least once each day; however, no operation and maintenance log books are maintained of daily activities. Laboratory testing for all facilities is performed in a small laboratory at the sewer district office.

Three of the four treatment facilities utilize contact stabilization package plants. The fourth plant is a two-cell, naturally-aerated stabilization pond. Sludge generated at the mechanical plants is transported and disposed of in the sludge lagoons at the Duckett Creek Plant. Summary descriptions of these four treatment facilities are as follows:

- Duckett Creek Plant - The Duckett Creek Plant is located near the intersection of Jung's Station Road and Greens Bottom Road (see Figure 2-1). The plant is not near any development. There is room for expansion of the plant, but additional property adjacent to the existing plant site would have to be purchased. The plant is a 1-mgd contact stabilization package plant built above ground with three sludge lagoons. Two of the lagoons are at capacity. The third lagoon was recently converted from an effluent polishing lagoon to a sludge lagoon. The plant is operating at 54% of the flow capacity and 50% of the BOD capacity; however, the plant effluent does not consistently meet BOD and TSS permit limits. One factor significantly affecting plant performance is clarifier short circuiting owing to unlevel weirs and mixed liquor suspended solids (MLSS) splashing over the clarifier/aeration tank common wall. The plant is operated in a modified contact stabilization mode. The return sludge is pumped into the digester that is connected to the stabilization tank. Essentially, this mode of operation extends the detention time of the stabilization process. The sludge settleability in the stabilization tank is monitored to determine when sludge needs to be wasted. When the sludge settleability exceeds 500 mg/l, the valve connecting the digester and stabilization tanks is closed. The digester is then decanted and sludge is removed to the sludge holding lagoons.

- Harvester-Dardenne Plant - The location of the Harvester-Dardenne plant and lift stations are shown in Figure 2-1. The plant is constructed above ground and is located in a residential area. The plant site has room for expansion on the existing property. The District also owns additional land at the site that is currently leased. The plant has two 0.5 mgd contact stabilization package units. The older plant has been in operation since 1970, and the new plant since 1979. Waste sludge is dewatered using a belt filter press prior to disposal at the Duckett Creek Plant. The plant is operating at 89% flow capacity and 78% BOD capacity. Plant effluent does not consistently meet the BOD and TSS permit limits. A number of factors that may contribute to exceedences of permit limitations are outlined below:

  -- Uneven flow splitting between the two package plants.
  -- Unlevel weirs in the older Clow plant.
  -- Low mixed liquor dissolved oxygen in contact and stabilization basins, and high sludge inventory.

  The discharge to the creek also was observed to have a considerable amount of foam, be light grey in color, and generate a slight odor.

  The two package plants are operated as traditional contact stabilization plants in that the return sludge is returned to the stabilization tank and excess sludge is wasted to the digester. Sludge wasting decisions are based on sludge settleability measurements taken in the stabilization tanks. When the settleability exceeds 500 mg/l, sludge is wasted. The air is turned off in the digesters during the day to allow solids compaction prior to pumping waste sludge to the belt filter press for dewatering. Dewatered sludge is hauled to the Duckett Creek Plant, where it is disposed of in lagoons. The Harvester-Dardenne Plant is considered an interim facility by MDNR and is required by its NPDES permit to be abandoned within 90 days after a trunk sewer is available. However, the Duckett Creek Sewer District is currently planning to phase out the plant by constructing a pumping station and force main. The sewage would be pumped from the Harvester-Dardenne site to the existing Duckett Creek Plant. Work on this plan is progressing, but final details of the plan are not yet available for inclusion in the EIS. The discharge from the Harvester-Dardenne wastewater treatment plant significantly pollutes a small unclassified tributary of Dardenne Creek. Dissolved oxygen concentrations are reduced to nearly zero in this tributary and fecal coliform concentrations are high. The tributary flows through residential and park areas which may be creating a potential health problem. The Harvester-Dardenne discharge causes violations of both the dissolved oxygen and unionized ammonia standards for several miles downstream in Dardenne Creek.

- South Plant - The location of the Highway 94-South Plant is shown in Figure 2-1. Two lift stations are located at the plant site for influent pumping and one for effluent pumping. The plant site is located in a poorly drained, low-lying area but has room for expansion. There are no residential areas near the plant site. The 0.08 mgd contact stabilization package plant is considered an interim facility and has been in operation since 1980. During past inspections, the effluent has appeared to be clear with few suspended solids. Further, an excessive amount of scum had accumulated on the clarifier surface because the skimming mechanism was in need of repair. Also, the sludge collection mechanism causes some problems in cold weather because the traveling bridge stops when excessive ice forms in the open return sludge trough. The process operation and control strategy is the same as that for the Harvester-Dardenne Plant. Sludge removal has been required from the plant only once in the last year.

- Boschertown Lagoon - The locations of the Boschertown lagoon and lift stations are shown in Figure 2-1. The plant is not located near residential areas but is visible from Route 94. There is room for expansion at the plant site, however, the adjacent land is not currently owned by the District. The plant is a two-cell stabilization lagoon. The first cell is 8.1 acres with an 8-foot operating depth. The second cell is 3.5 acres with a 3½-foot operating depth. There are no flow meters at the plant, so flow is estimated using population equivalents and water meter readings from commercial customers. The effluent does not consistently meet BOD and TSS permit limits. Plant operation involves manually turning on the effluent pumps for about 8 to 10 hours per day to maintain a desired pond level. Chemicals are used occasionally to control algae. NPDES permit conditions require the Boschertown lagoon to be abandoned within 90 days after a trunk sewer is available.

2.1.1.2 City of St. Charles

Collection

The City of St. Charles maintains approximately 680,000 linear feet of gravity sewer pipe ranging from 8 to 48 inches in diameter. Most of the smaller lines are constructed of vitrified clay pipe or polyvinyl chloride pipe. Larger-sized pipes are bituminous-coated, corrugated metal. Construction periods for the major interceptors are listed below.

Interceptor	Construction Period
Boschert Creek	early 1960s
Cole Creek	
(North of I-70)	mid 1960s
(South of I-70)	early 1970s
(Shirewood Extension)	1976-1978
Seeburger Road	1968-1969
Adams PS to Missouri River POTW	1965-1966
Adams PS to Boonslick Road	1975
Missouri River Phase II	1980
Sandfort Creek	1979-1981

Theoretical Flow

Sewer customers in the City of St. Charles receive potable water from both the City of St. Charles and Missouri Cities Water Company. St. Charles meters water at the water plant and at the service tap of each customer. These records indicate that only 10% of the water is lost as leakage or fire flow. The Missouri Cities Water Company probably experiences similar small losses.

Potable water records for the period from December 1981 through September 1982, were examined to estimate the theoretical wastewater flow. The flow during December 1981 was the lowest and indicated that the theoretical wastewater flow is about 3.61 mgd. The calculations are summarized as follows:

Flow During December 1981

Description	Gallons/Month
Water supplied by St. Charles	112,999,000
Water Supplied by Mo Cities Water Co.	11,352,600
Total Potable Water	124,351,600
% to Sewers	90%
Theoretical Sewage	111,916,000
	3.61 mgd

This flow was divided among four service areas in proportion to population as shown in the following tabulation.

Description	Population	Theoretical sewage, mgd
Total	47,972	3.61 (73 gpcd)
Mississippi River Plant	32,254	2.4
Missouri River Plant	14,563	1.2
Heatherbrook Lagoon	475	0
St. Charles Trails Plant	680	0

Treatment

The City of St. Charles operates and maintains four wastewater treatment plants and seven lift stations (two located at plant sites) with a staff of 27 people. The staffing is as follows: 1 plant manager, 1 process control specialist, 15 sewage treatment plant operators, 6 maintenance mechanics, and 3 additional operators at the Missouri River Plant, and 1 clerk. Most of the staff are assigned to the Mississippi River Plant.

In general, the plants and lift stations appear to be well maintained. All lift stations and small treatment plants are inspected once each day. Most laboratory tests for all facilities are performed at the Mississippi River Plant laboratory, although some routine tests, such as pH and settleable solids, for the Missouri River Plant are performed daily at that plant site. Tests for Missouri River Plant permit requirements (BOD, TSS) are performed at the Mississippi River Plant. Sludge generated at all St. Charles' facilities is disposed of at the Mississippi River Plant. Summary descriptions of these wastewater treatment facilities are as follows:

- Mississippi River Plant - The Mississippi River Plant is located at the end of Seeburger Road near Dwyer Road in St. Charles County (Figure 2-1). The plant is not near any development and there is sufficient room for expansion. The plant is a 5.5 mgd advanced wastewater treatment facility. The basic plant is an activated sludge system, and unit processes include influent screening and pumping, aerated grit chamber, comminution, primary settling, aeration, secondary clarification, and chlorination. The plant was originally designed to filter plant effluent by means of carbon adsorption, but the carbon adsorption system is currently used only to produce process water for the plant. Since the plant can meet its discharge permit limitations without the activated carbon system and the operating costs are high, carbon adsorption is not used routinely. The waste secondary sludge is gravity thickened and combined with the primary sludge in an aerated sludge holding tank. The combined sludge is dewatered with pressure filter presses and incinerated in a multiple hearth incinerator. The ash is pumped to an ash lagoon on the west side of the plant site. The sludge handling system is presently operated 4 days per week on a 24-hour basis.

  The plant is operating at 75% flow capacity and 49% BOD capacity. The plant consistently meets effluent discharge limitations except for fecal coliforms. However, there are times when a portion of the flow bypasses secondary treatment because of high flows and mud infiltration. The suspected source of the mud is open manholes in creekbeds. A major problem during high river stages is that effluent will not flow by gravity to the river because the plant discharge point is below the river level. Plant operators have removed the carbon media from one of the carbon filters so that effluent can be pumped to the river through the one carbon filter which provides adequate head for the effluent to be discharged. The plant is operated on the constant food-to-microorganism ratio (F/M) control strategy. The present target F/M is 0.325. The plant uses a computer to store data and perform process control calculations. The process control specialist performs laboratory tests and process calculations and recommends to the plant manager process changes or modifications needed to achieve effluent permit limitations.

- Missouri River Plant - The Missouri River Plant is located on North Main Street north of Ed Bales Memorial Park in St. Charles, Missouri (Figure 2-1). The plant is near residential development but has room for expansion. The plant is a 3.0 mgd primary treatment facility with an aerated sludge holding tank, sludge dewatering equipment, and a multiple hearth incinerator. The sludge dewatering equipment and incinerator are not operated. Sludge is hauled to the Mississippi River Plant for dewatering, incineration, and disposal. The plant is operating at 106% flow capacity and floods occasionally, making it necessary to bypass raw sewage to the Missouri River at the Adams Street pumping station.

- St. Charles Trails Plant - The St. Charles Trails Plant is located on Pralle Lane near the St. Charles Trails Apartments approximately 1/4 mile east of Highway 94 South (Figure 2-1). The plant is not near developed areas and there is some room for expansion. The plant is an 87,500 gpd extended aeration package treatment plant. It is inspected daily and samples are collected for analysis at the Mississippi River Plant. The basic process control strategy used at the plant is constant MLSS (Mixed Liquor Suspended Solids) which is based on a specific F/M (food to micro-organism ratio) range (0.07-0.08). The plant is operating at 34% flow capacity and does not consistently meet effluent BOD and TSS permit limits. The operator has reported problems in controlling the MLSS levels because washout of biological floc occurs periodically. During past inspections, the plant discharge was murky but contained few suspended solids. The clarifier had an excessive amount of sludge build-up and leaves floating on the surface. The operator has reported that leaves frequently clog the skimming air lift pump. Sludge is disposed of at the Mississippi River Plant when sludge wasting is necessary. The St. Charles Trails package plant must be abandoned within 90 days after a trunk sewer is available, according to its NPDES permit. The City of St. Charles has plans to take this plant off line, with its flow to be handled at the Missouri River plant site.

- Heatherbrook Lagoon - The Heatherbrook lagoon is located in the Heatherbrook Subdivision off Pralle Lane in St. Charles County (Figure 2-1). The lagoon is near development and has no room for expansion. The facility is a single-cell waste stabilization lagoon with the capacity to treat an average daily flow of 51,500 gallons. It is inspected daily and effluent samples are collected for analysis at the Mississippi Plant. The lagoon is operating at 39% flow capacity. Effluent BOD, TSS, and pH permit limits are not consistently met. At the time of inspection, the discharge appeared light green in color with few suspended solids. Chemicals are used periodically to control algae and duckweed. The Heatherbrook lagoon must be abandoned within 90 days after a trunk sewer is available, according to its NPDES permit. The City of St. Charles has plans to take this facility offline, with its flow to be handled at the Missouri River Plant site.

2.1.1.3 City of St. Peters

Collection

The City of St. Peters has about 930,000 linear feet of gravity sewer pipe (including Missouri Cities Water Company sewers), ranging from 8 to 42 inches in diameter. The majority of small pipe is constructed of vitrified clay. Types of pipe and periods of construction for the major interceptors are listed below:

Interceptor	Type	Construction Period
Original System	VCP	1968-1969
West Branch, Spencer	VCP	1971-1972
Main Branch, Spencer	Plastic	1972-1974
Brown Road to Missouri Cities	RCP	1972
POTW to Brown Road	ACP	1980

Sewer customers of the City of St. Peters receive potable water from three sources: City of St. Peters, Missouri Cities Water Company, and private wells. Some water customers do not use the public sewers. Examination of St. Peters' potable water records for the period from October 1981 through October 1982, and estimates of discharges from other customers indicated a theoretical wastewater flow of about 1.72 mgd.

Treatment

The City of St. Peters operates and maintains one treatment plant (Spencer Creek) and five lift stations (two located at the plant site). The Hermitage Subdivision lift station is privately owned and maintained and pumps sewage to the St. Peters treatment plant. In general, the Spencer Creek lift stations appear to be well maintained. Most of the equipment at the treatment plant is new. The plant was recently modified and expanded, and started operation during January 1982. The plant is not located near any existing development and there is sufficient area to expand if necessary.

The Spencer Creek plant is located near the St. Peters' water treatment plant (Figure 2-1). When both the water and wastewater plants were expanded, a common control room for both plants (located in the water plant) was built so both plant controls and alarms could be monitored from one location. The control room is manned 24 hours per day, 7 days per week. The staffing for the water and wastewater plants is combined. A total of nine operators (all certified in water and wastewater) are responsible for the operation and maintenance of both plants. A separate field crew of six persons is responsible for maintaining the wastewater collection lines and lift stations, and the potable water mains and booster stations.

The Spencer Creek plant capacity is 3.0 mgd and utilizes the extended aeration mode of the activated sludge process. The plant is operating at 57% of flow capacity and 51% of BOD capacity. The plant effluent does not consistently meet permit limits for TSS, but does meet BOD limits. Based on observations and discussions with plant operators, the following factors appear to contribute to performance problems:

- Excessive sludge inventory and sludge age.
- Fouling of effluent weirs.
- Excessive inflow during rainfall events.
- Inadequate hydraulic head from the final clarifiers to the creek during high water levels in the creek.

The plant operator has reported that his method of process control is to maintain 5,000 mg/l MLSS concentration in the aeration basin, based on recommendations from the O&M manual. At the time of the inspection, the MLSS was much greater than 5,000 mg/l. The MLSS was a dark brown color with some foaming in the aeration basin. The final clarifiers had an excessive amount of brown foam on the surface. Ashing of solids on the clarifier surface was also evident, indicating an excessive sludge age. The clarifier weirs are located so far below ground that access for routine cleaning is difficult. Some of the weirs also were partially blocked with large solids and slime growth.

The operator also has reported major operating problems during excessive rainfall events. Inflow of runoff into sewer manholes was reported to cause major increases in flow during storms. Another problem experienced during rainfall events is the inability of the effluent to flow by gravity to the receiving stream since the stream level during heavy rains is higher than the discharge point. The operators have constructed a clarifier effluent bypass to the sludge holding pond because of this problem. When gravity flow to the creek is not possible, the effluent flow is diverted to the sludge holding pond until the creek level falls. The effluent stored in the pond is returned to the head of the plant when the final effluent can flow by gravity to the creek. Violations of the dissolved oxygen and unionized ammonia standards occur for several miles below the Spencer Creek wastewater treatment plant. The effluent is also causing a high concentration of suspended solids and lime sludge deposits in Spencer Creek.

Spencer Creek is unclassified; however, examination of the original maps from which the standards were derived revealed that it should be listed as a class "C" stream. Therefore, the stream should be classified for protection of aquatic life and livestock and wildlife watering. Spencer Creek would be reclassified for these uses when the water quality standards are updated.

2.1.1.4 Portage des Sioux

Collection

Portage des Sioux has approximately 11,000 linear feet of gravity sewer pipe, all of which is 8 inches in diameter. The original system was constructed in 1956 using vitrified clay pipe. Since that time, extensions have been added utilizing PVC pipe.

Treatment

Portage des Sioux has a community septic tank that discharges to the Mississippi River. Two lift stations and a network of 8-inch diameter sewers comprise the collection system.

The septic tank has a liquid capacity of 27,000 gallons. Flow is not monitored, but was estimated at 16,700 gpd. The treatment system consistently violates BOD and TSS permit limitations. The community septic tank is not an adequate wastewater treatment system, and the inflow volumes, described in the City's 1978 Facility Plan, exacerbate performance problems. The existing septic tank area has no room for expansion or upgrading of the system.

The 1978 Portage des Sioux Facility Plan recommended a rotating biological contactor plant located on the east side of town. The existing septic tank and pumping stations would be abandoned and a new pumping station and interceptor sewer along Second Street would be constructed. The estimated capital cost of the complete system in 1978 was $823,000 with annual O&M costs of $23,600 per year. User charges were estimated at $13.20 per month based on 190 connections. Another option that would expand the service area to include sewers in the north and northeast parts of town would increase the rate to $20.70 per month based on 219 connections. A bond issue for the project failed in 1979 and minimal activity on the project has occurred since then.

2.1.1.5 Private Wastewater Collection and Treatment Systems

In addition to the four major centralized municipal wastewater collection and treatment systems, there are a number of private systems (see Figure 2-2). Most of these systems would be abandoned as soon as a trunk line sewer becomes available. Brief descriptions of each of these private systems follow:

- Yacht Club of St. Louis - The Yacht Club maintains a septic tank and sand filter that discharges to the Mississippi River. The system is constructed totally below ground with a submerged outfall. Condition of the facilities and effluent quality could not be determined. It was reported that the septic tank was recently replaced and no problems are known to exist with the new system. The septic tank serves the clubhouse, which is the only building with sanitary facilities.

- St. Joseph Church and School - The St. Joseph Church and School wastewater treatment facility is located west of Motherhead Road in Cottleville, Missouri. The treatment plant is directly southwest of the school near the school soccer field, and is a 10,000 gpd extended aeration package treatment plant. Flows and effluent characteristics are not monitored. During inspection of the plant, it was observed that the blower was running but the aeration system was not operating because of a broken air diffuser pipe. The aeration basin contents appeared clear. The discharge line is connected into a storm sewer before discharging to a drainage ditch. The discharge appeared clear; however, sludge deposits in the corrugated storm sewer could be seen at the outfall. No routine operation and control of the plant is performed.

- Riverview Hills Subdivision - The Riverview Hills Subdivision wastewater treatment plant is located near the intersection of Rio Vista and South River roads. The plant is a 5,600 gpd septic tank discharging into an open sand filter 50 feet in diameter. The facility can be easily seen from some of the subdivision residences. The plant is operating at 49% of flow capacity (based on 1980-81 data). BOD and TSS permit limitations are not consistently met. During the plant inspection, it was observed that the discharge was clear and contained few suspended solids. A slight odor was noticeable near the sand filter. The septic tank had not been pumped out for 5 years. Once a trunk sewer is available, Riverview Hills would have 180 days to abandon their treatment facilities according to their NPDES permit.

- Timbercrest Subdivision - The Timbercrest Subdivision wastewater treatment plant is located about 2,000 feet north of the intersection of Hemsath and South Missouri River roads. The plant is a one-cell lagoon designed to treat a population equivalent of 56. Many of the homes overlook the lagoon. The lagoon was not accessible at the time of inspection. The facility does not have a discharge permit, although the owner of the facility could not be determined.

- Tee Kay Mobile Manor - The Tee Kay Mobile Manor wastewater lagoon is located off Highway 40-61, 1 mile northwest of Weldon Spring, Missouri. The plant is a single-cell waste stabilization lagoon designed to treat an average daily flow of 16,500 gallons. The plant is operating at 66% flow capacity (based on 1980-81 data). The effluent does not consistently meet BOD and TSS permit limits. At the time of inspection, the discharge appeared deep green in color and changed the creek color from clear (upstream) to green (downstream). Many of the mobile homes overlook the lagoon. Once a trunk sewer is available, the Tee Kay lagoon would be abandoned within 180 days in accordance to their NPDES permit.

- Martell Subdivision - The Martell Subdivision sewage lagoon is located south of Doris Avenue approximately 2,000 feet east of Highway 40-61. The treatment system consists of a two-cell waste stabilization lagoon designed to treat an average daily flow of 13,000 gallons. The lagoon was inspected during February 1982 by a MDNR official. At that time, the following problems were noted:

  -- Facility lacked the required all-weather access road.
  -- Facility lacked the required fence enclosure.
  -- Facility lacked the required warning signs.
  -- Emergent vegetation (cattails) existed in the lagoon.
  -- Excessive vegetation existed on the water's edge and on the dikes.
  -- Erosion and rodent activities were damaging the lagoon dikes.
  -- Contents of the primary cell were septic and malodorous.

  Monitoring reports on the effluent have not been filed with the state, therefore treatment performance could not be analyzed. Once a trunk sewer is available, the Martell lagoon must be abandoned with 180 days according to their NPDES permit.

2.1.2 Onsite Wastewater Treatment Systems

2.1.2.1 General Overview

Most of the estimated 5,000 onsite systems in the Facility Planning Area are either septic tanks with soil absorption systems or aerated tanks with surface discharges.* Many of these systems were observed by Sverdrup & Parcel and Associates, Inc. personnel, to be failing, as evidenced by surface discharges of partially treated effluent. These discharges often were observed to have accumulations of sludge, toilet paper, and grease. A common practice in the area, in order to eliminate or prevent effluent discharges onto lawns, is to pipe the effluent (either individually or in common sewers) to roadside ditches or creekbeds. The discharges from these pipes often cause a continuous flow of partially treated effluent in the drainage ditches. In general, the onsite systems appear to be poorly maintained. Septic tanks are usually not pumped until they have overflowed and backed up. Sverdrup & Parcel and Associates, Inc. identified numerous specific problem areas where onsite systems were noted as failing and noted these areas on a map (Figure 2-3). Four of these were in the floodplain areas while the majority (24) were in the uplands area; however, no criteria (e.g., MDNR Division of Geology and Land Survey) were supplied as to how these problem areas were selected, what number of residences were in each, or what percentage of the residences had problems.

2.1.2.2 Soil Suitability

The Soil Conservation Service (SCS) has rated 5% of the planning area as having soils with slight limitations for onsite systems, 8% with moderate limitations, and 87% with severe limitations. These soil limitations and poor operation and maintenance procedures combine to cause the high failure rate for onsite systems in the Facility Planning Area. The terrain of the planning area generally falls into two categories: uplands and floodplains. These landforms have different restrictions for onsite systems.

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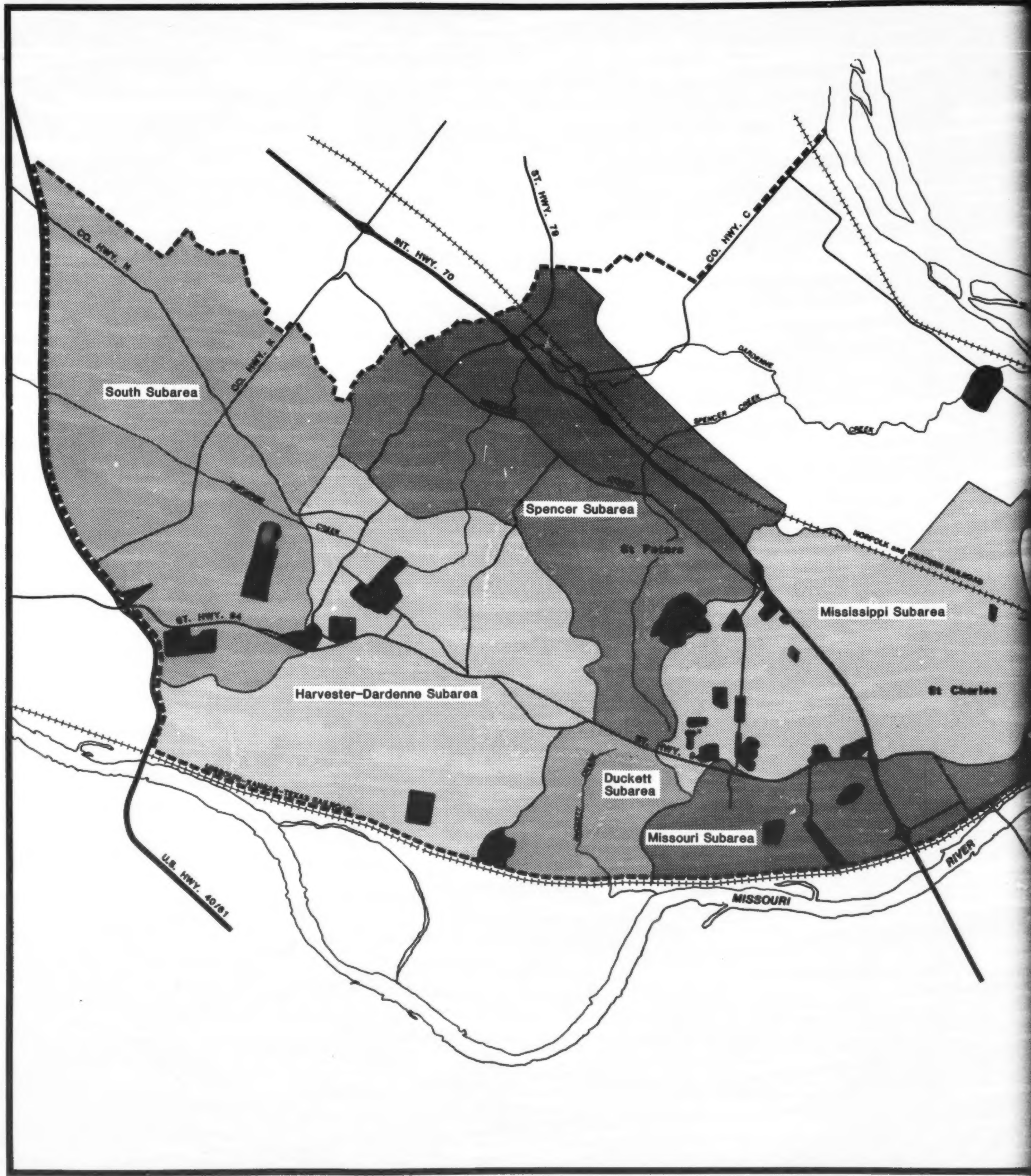
* Based on 1980 census information, (103,000 planning area inhabitants) - [48,000 St. Charles pop. + 22,000 St. Peters pop. + (3 residents per connection) (6,327 connections in Duckett Creek S.D.)] = 14,000 unsewered residents. 14,000/3 residents per household = approximately 5,000 onsite systems.


CO. HWY. N
CO. HWY. K
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
DARDENNE
SPENCER CREEK
CREEK
South Subarea
Spencer Subarea
St Peters
NORFOLK and WESTERN RAILROAD
Mississippi Subarea
ST. HWY. 94
Harvester-Dardenne Subarea
St Charles
ST. HWY.
Duckett Subarea
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri Subarea
U.S. HWY. 40/61
MISSOURI
RIVER

2-23.a

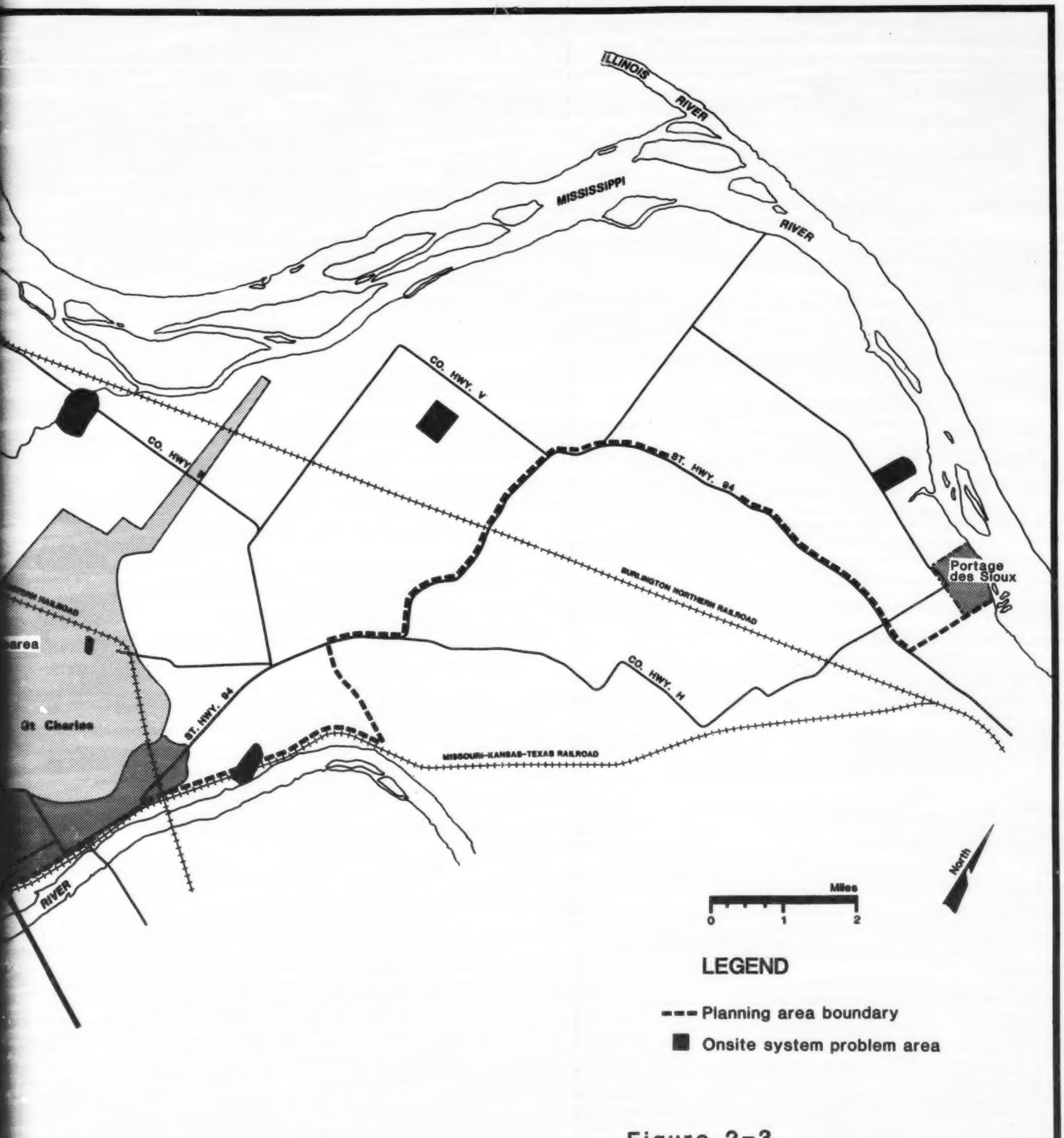

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
RAILROAD
area
CO. HWY. H
St. Charles
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
Miles
0
1
2
North
LEGEND
Planning area boundary
Onsite system problem area

Figure 2-3.
Onsite System Problem Areas.

The primary restriction to onsite systems in the floodplain is the shallow depth to groundwater due to fine-textured soils. MDNR guidelines suggest a minimum of 4 feet between the bottom of the pipes in the soil absorption system and the groundwater. All of the developments along the Mississippi River (from Portage des Sioux to Peruque) have insufficient depth to the groundwater to allow adequate wastewater treatment in a soil absorption system. Other upland communities (Prairie Homes and Orchard Farms) are higher in elevations (above 440 feet msl -- normal Mississippi River pool elevation is 419 feet msl), and presumably have a sufficiently thick aerated soil zone (10-15 feet) for adequate wastewater treatment. All of these floodplain developments (except Portage des Sioux, which has a municipal water supply system) obtain drinking water from shallow wells in the alluvial aquifer. Floods on the Mississippi River periodically inundate the onsite systems in these areas and render them inoperable for brief periods of time. The subdivision west of Portage des Sioux, and Kampville are two problem areas that have these characteristics. The other two floodplain problem areas are located in areas that flood less frequently and that have coarse-textured soils. One is located west of Orchard Farm and the other is located east of St. Charles. Although wetness is a problem here, it is generally for a limited period. The groundwater under these two areas would not likely become contaminated because the soils are sufficiently well-aerated or are medium textured.

The upland portions of the planning area have several features that affect the suitability of onsite systems. The potential for groundwater contamination occurs in several areas due to septic tank leachate discharges into alluvial aquifers bordering small tributary streams, or into sinkholes. Although karst topography in the planning area is not well developed, isolated sinkholes or groups of sinkholes do occur, generally along the "river bluff" sections. Streams that are adjacent to these areas with sinkholes may lose some stream flow to the groundwater. Sinkholes and underground solution channels can act as conduits between onsite systems and wells, resulting in possible contamination of drinking water. The karst areas with sinkhole features are identified on the soils maps, primarily between Taylor Branch and Duckett

Creek. Only a small portion of one problem area is located on the areas where sinkholes are identified. Most of the karst areas are open areas or sewered subdivisions. Thus, the potential for contamination of water supply wells is slight.

Soil characteristics in the upland areas may also limit the use of onsite systems. The soil absorption system (leach field) requires a soil with sufficient porosity to allow adequate passage (and purification) of wastewater. As previously noted, most of the planning area soils have severe limitations for onsite system design and installation, primarily due to low percolation rates. Soils with low percolation rates could cause effluent from onsite systems to pool at the discharge point and, eventually, run off into the surface drainage. This problem could become more serious in dense residential developments, where "tight" soils and insufficient sizing and spacing of soil absorption systems may create "swampy" areas of effluent-saturated soils. The other problem areas in the uplands have various suitabilities for onsite systems. Some areas have soils that are well suited for onsite systems (although rated as "severe" because of the steep slopes), while other areas are poorly suited. These poorly suited areas generally have very slow percolation rates and a concomitant high water table. These problem areas are located toward the west end of the planning area. Most of the identified problem areas in the uplands have severe limitations for onsite systems, although the soil and topographic conditions are such that the limitations can be overcome with proper design.

2.1.2.3 Water Quality and Public Health Effects

The primary environmental effect from onsite systems in the planning area is the potential contamination of either surface water or groundwater quality. Although each failing onsite system contributes only small amounts of contaminants to ground or surface waters, the total flow of partially treated onsite system effluent in the planning area was calculated in the facilities plan to be approximately 0.5 mgd*. Many of the interior streams in the planning area have poor water quality. The addition of partially treated onsite system effluent, either as continuous discharges or as non-point source runoff following precipitation, would contribute to the already poor water quality caused by urban runoff, sewer overflows or bypasses, and point-source discharges. Surface and groundwater contamination increases the potential for public health hazards from contact with, or ingestion of, water containing harmful bacteria and other pathogens.

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* Based on a 50% failure rate (2,500 failing onsite systems). Assuming 2,500 onsite systems and 85 gal/capita/day and 3 residents/household = 563,000 gal/day total flow from failing onsite systems. Although several local officials claim that nearly 100% of the onsite systems are failing in some manner, a 50% failure rate was chosen as a more conservative estimate, based on field observations.

The severity of the failing onsite system problem centers on the potential public health hazard issue. Some problem exists in the floodplain developments due to the potential for contamination of private drinking water systems by onsite system effluents. A significant problem occurs in the densely populated, unsewered developments in the upland portions of the planning area. Surface discharge of onsite system effluent onto lawns, pastures, or vacant lots, or into roadside ditches or creek beds, is common practice in many parts of the planning area. Contact with these bacteria-laden waters by pets, domestic livestock, or children creates a health hazard for area residents. In addition, many areas have formally developed common effluent collection pipes to transport the effluent from failing onsite systems to vacant lots or small creeks. This practice increases the concentration at point of discharge and can cause further water quality degradation in streams now classified by MDNR as effluent-limited.

Another, more localized problem occurs in those areas with sinkholes and other characteristics of karst topography. Discharge of onsite system effluent into sinkholes may result in groundwater contamination and a potential public health hazard if the aquifer is a source of potable water.

2.1.2.4 Regulation of Onsite Systems

Few ordinances regulating onsite wastewater treatment systems exist in the planning area. Municipalities have the legal authority necessary to regulate onsite systems, and some with municipal wastewater collection and treatment systems (e.g., St. Peters and St. Charles) require that all residences with a failing onsite system within 100 or 200 feet, respectively, of an existing sewer line be connected to the municipal system. Duckett Creek Sewer

District requires any residence with a failing onsite system to hook up if the residence is within 100 feet of a sewer. Onsite systems in the remainder of the planning area are unregulated after installation. The St. Charles County building commissioner has established minimum standards for the installation of septic tank systems (at least a 1,250-gallon tank with a soil absorption system with more than 100 square feet of trench bottom). Complaints and problems concerning onsite system failures in unincorporated areas of St. Charles County are referred to the St. Charles County Health Department. Although the health department personnel have no enforcement powers, they are effective in 75% of the incidents in pursuading the offender to resolve the problem(s) causing the complaint (by telephone, Roger Dunajeik, St. Charles County Health Department, to WAPORA, Inc., 19 April 1984). State regulations apply only to developments installing more than 10 dwellings served by onsite systems, or when surface water quality degradation is caused by onsite systems effluent.

Missouri House Bill 371 was passed in August 1983 and enables sewer districts to control onsite systems by authorizing the districts to pass standards on septic tank design and performance. Although no standards have been issued yet, the new law provides for a more effective means of regulating onsite systems in the unincorporated areas of St. Charles County. Recommendations for utilizing the provisions of Missouri House Bill 371 are provided on page 2-109 of this Draft EIS, discussing wastewater management alternatives for existing onsite system areas.

2.2 Identification of Wastewater Management Planning and Design Assumptions and System Components

Sections 2.1.1 and 2.1.2 of this EIS provided a description of existing centralized collection and treatment systems, and existing onsite treatment systems currently operating in the planning area. To plan for proper wastewater management in the future, one must first determine future conditions. One must also determine what kind of economic evaluation criteria will be used for evaluating various alternatives, in order to compare all alternatives on an equal basis. These conditions (planning period/population, wastewater flows, effluent limitations, and economic criteria) remain the same and are applicable to all alternatives, regardless of what size or type of alternative collection and treatment system is evaluated.

In this section, these factors and components associated with the various wastewater treatment systems are identified. Wastewater loadings, effluent requirements, and costs are all equally important in designing a functional and cost-efficient treatment system. Once standard planning and design information is developed, the various components and component options of a wastewater system can be identified and evaluated.

2.2.1 Design and Planning Factors

Several key assumptions must be factored into designing a system to adequately collect and treat wastewater. The planning period must first be established and then the volume of sewage, considering infiltration and inflow, that would be collected and transported by the system is calculated. The costs for collecting and treating the sewage to a required level of effluent quality must also be estimated and the costs then estimated for the projected life of the system. The major planning and design factors used to arrive at the waste treatment systems proposed for the Duckett Creek planning area are discussed in the following sections.

2.2.1.1 Planning Period

Current USEPA guidelines specify that a planning period of 20 years be used in facilities planning (USEPA 1982a). Although some structures like sewer pipelines can last 40 or 50 years, most major sewage treatment process equipment has a design life of 15 to 20 years. A 20-year design period is reasonable since it is long enough to satisfy a community's needs for a reasonable period, yet allows for additional facility expansion or upgrade at a time when most equipment would be wearing out. The Missouri Department of Natural Resources (MDNR) has approved the period 1985-2005 as the facilities planning period for this project.

2.2.1.2 Wastewater Flow and Load Factors

Several flow conditions are important in the design of wastewater treatment facilities. The average daily flow is needed to design treatment plant units, while peak flow is needed to size interceptor sewers, pumping stations, and the hydraulic capacity of the treatment plant. Further, the base flow, which is the average daily flow from residential, commercial, and industrial sources without including an allowance for infiltration and inflow, must be calculated.

Based on existing wastewater flows in the planning area and population estimates for each major treatment plant service area, a base flow of 75 gallons per capita per day (gpcd) was established. Infiltration and inflow (I/I) quantities in the planning area were determined by comparing measured flows at major wastewater treatment plants to base flows. Infiltration and inflow were not considered to be excessive in the planning area.

For each of the major service areas, average flows were computed by adding base flow, I/I, and industrial contributions. Infiltration was assumed to increase by 1% per year due to deterioration in the system. Peak flows for each watershed were estimated by multiplying the base flow by a peaking factor, as recommended by MDNR guidelines, where:

$$Q\ max = Q\ avg \times [18 + (P)^{\frac{1}{2}}]/[4 + (P)^{\frac{1}{2}}]$$

and P = population in thousands.

Summaries of average and peak wastewater flows for the major service areas are shown in Table 2-5 for years 1985, 1990, 1995, 2000, and 2005. Wasteloads were calculated in the Draft Facility Plan from existing raw wastewater data--NPDES Discharge Monitoring Reports from 1981 and 1982. BOD concentrations averaged 162 mg/l, while TSS values averaged 196 mg/l. Estimated total future wasteloads also are presented in Table 2-5.

2.2.1.3 Effluent Requirements

The effluent limitations for direct dischargers into waters in the Duckett Creek Planning Area are summarized in Table 2-6. Many of the permits issued for plants listed below have expired; however, the requirements still remain in effect. Public sanitary wastewater treatment facilities operating under NPDES permits include:

TABLE 2-5

SUMMARY OF FLOW ESTIMATES AND TOTAL ORGANIC LOADS PROJECTED FOR THE MAJOR SERVICE AREAS FOR EACH 5-YEAR PERIOD FROM 1985-2005

	1985 FLOW ESTIMATE							
Area	1985 Pop.	gpcd	1985 Baseflow (mgd)	I/I (mgd)	1985 I/I (mgd)	1985 Avg. Annual Flow (mgd)	Peak Factor	1985 Peak Flow (mgd)
St. Charles								
Mississippi River	37,100	75	2.78	1.73	1.73	4.51	2.39	10.8
Missouri River	17,900	75	1.34	2.01	2.01	3.35	2.70	9.0
St. Peters								
Spencer Creek	30,100	75	2.26	0.10	0.10	2.36	2.48	5.8
Duckett Creek								
Duckett Creek	8,300	75	0.62	0.10	0.10	0.72	3.03	2.2
Harvester-Dardenne	23,900	75	1.79	0.28	0.28	2.07	2.58	5.3
South	10,300	75	0.77	--	Negl.	0.77	2.94	2.3

	1990 FLOW ESTIMATE							
Area	1990 Pop.	gpcd	1990 Baseflow (mgd)	I/I (mgd)	1990 I/I (mgd)	1990 Avg. Annual Flow (mgd)	Peak Factor	1990 Peak Flow (mgd)
St. Charles								
Mississippi River	42,900	75	3.22	1.73	1.82	5.04	2.33	11.7
Missouri River	20,700	75	1.55	2.01	2.11	3.66	2.64	9.7
St. Peters								
Spencer Creek	36,400	75	2.73	0.10	0.10	2.83	2.40	6.8
Duckett Creek								
Duckett Creek	9,300	75	0.70	0.10	0.10	0.80	2.99	2.4
Harvester-Dardenne	25,800	75	1.94	0.28	0.29	2.23	2.54	5.7
South	10,800	75	0.81	--	Negl.	0.81	2.92	2.4

Table 2-5 (cont'd)

1995 FLOW ESTIMATE

Area	1995 Pop	gpcd	1995 Baseflow (mgd)	I/I (mgd)	1995 I/I (mgd)	1995 Avg. Annual Flow (mgd)	Peak Factor	1995 Peak Flow (mgd)
St. Charles								
Mississippi River	48,800	75	3.66	1.73	1.91	5.57	2.27	12.6
Missouri River	23,600	75	1.77	2.01	2.22	3.99	2.58	10.3
St. Peters								
Spencer Creek	41,200	75	3.09	0.10	0.11	3.20	2.34	7.5
Duckett Creek								
Duckett Creek	10,400	75	0.78	0.10	0.11	0.89	2.94	2.6
Harvester-Dardenne	28,000	75	2.10	0.28	0.31	2.41	2.51	6.0
South	13,000	75	0.98	--	Negl.	0.98	2.84	2.8

2000 FLOW ESTIMATE

Area	2000 Pop	gpcd	2000 Baseflow (mgd)	I/I (mgd)	2000 I/I (mgd)	2000 Avg. Annual Flow (mgd)	Peak Factor	1995 Peak Flow (mgd)
St. Charles								
Mississippi River	54,900	75	4.12	1.73	2.02	6.14	2.23	13.7
Missouri River	26,600	75	2.00	2.01	2.33	4.33	2.53	11.0
St. Peters								
Spencer Creek	46,400	75	3.48	0.10	0.12	3.60	2.29	8.2
Duckett Creek								
Duckett Creek	11,200	75	0.84	0.10	0.12	0.96	2.91	2.8
Harvester-Dardenne	29,800	75	2.24	0.28	0.33	2.57	2.48	6.4
South	15,700	75	1.18	--	Negl.	1.18	2.76	3.2

Table 2-5 (concluded).

Area	2005 Pop	gpcd	Baseflow (mgd)	I/I (mgd)	2005 I/I (mgd)	2005 Avg. Annual Flow (mgd)	Peak Factor	2005 Peak Flow (mgd)
	2005 FLOW ESTIMATE							
St. Charles								
Mississippi River	60,500	75	4.54	1.73	2.11	6.65	2.19	14.6
Missouri River	29,300	75	2.20	2.01	2.45	4.65	2.49	11.6
St. Peters								
Spencer Creek	51,900	75	3.89	0.10	0.12	4.01	2.25	9.0
Duckett Creek								
Duckett Creek	11,200	75	0.84	0.10	0.12	0.96	2.91	2.8
Harvester-Dardenne	31,000	75	2.32	0.28	0.34	2.66	2.46	6.5
South	18,600	75	1.40	--	Negl.	1.40	2.68	3.8

ESTIMATED TOTAL WASTELOADS*

Year	Avg. Annual Flow (mgd)	BOD (lb/day)	TSS (lb/day)
1985	13.78	18,600	22,500
1990	15.37	20,800	25,100
1995	17.04	23,000	27,800
2000	18.78	25,400	30,700
2005	20.33	27,500	33,200

* Assuming BOD = 162 mg/l and TSS = 196 mg/l

Source: Sverdrup & Parcel and Associates, Inc. (1984)

TABLE 2-6
EFFLUENT REQUIREMENTS FOR WASTEWATER TREATMENT FACILITIES IN THE DUCKETT CREEK PLANNING AREA*

Discharging Facility	Class	Stream	BOD (mg/l)	TSS (mg/l)	Dissolved Oxygen	Fecal Coliform (col/100/ml)	pH
Duckett Creek Sewer Dist. Boschertown Lagoon	P	Missouri River	30	60	—	—	6.0-9.0
Riverview Hills Subdivision			30	60	(D)	200	6.0-9.0
City of St. Charles, Main St. Water Treatment Plant			—	0.2+	—	—	6.0-**
City of St. Charles, Missouri Sewage Treatment Plant			30	30	—	—	6.0-9.0
City of St. Charles, Heatherbrook Lagoon			30	60	—	—	6.0-9.0
Findett Corporation	P1	Dardenne Creek, Mouth to Sur. 1704, Sur. 1704 to 21, 46N,1E					
Outfall #001			—	30	—	—	6.0-9.0
Outfall #002	P		—	30	—	—	6.0-9.0
Outfall #003			—	30	—	—	—
Duckett Creek Sewer Dist. Harvester-Dardenne Sewage Treatment Plant		Dardenne Creek	30	30	—		6.0-9.0
Hitchiner Mfg. Company			30	30	—	—	6.0-9.0
Duckett Creek Sewer Dist. Highway 94 South Sewage Treatment Plant			30	30	—	—	6.0-9.0
Martell Subdivision			30	30	—	—	6.0-9.0
St. Joseph Church & School			30	30	(D)	200	6.0-9.0
Duckett Creek Sewer Dist. Duckett Creek Sewage Treatment Plant		Duckett Creek	30	30	—	—	6.0-9.0
City of St. Charles, Mississippi River Sewage Treatment Plant	P	Mississippi River	30	30	(D)	200	6.0-9.0
City of Portage des Sioux			30	30	—	—	6.0-9.0
Yacht Club of St. Louis				(NPDES permit pending)			
City of St. Charles, Elm Point Water Treatment Plant		Cole Creek					
Outfall #001			—	0.10+	—	—	6.0-**
Outfall #002			—	0.10+	—	—	6.0-**
City of St. Charles, St. Charles Trails Sewage Treatment Plant		Taylorbrook Creek	30	30	—	—	6.0-9.0
Timbercrest Subdivision				(No NPDES permit)			
Tee Kay Mobil Manor		Schote Creek	30	30	(D)	—	6.0-9.0
City of St. Peters, Spencer Creek Sewage Treatment Plant		Spencer Creek					
Outfall #001			30	30	—	—	6.0-9.0
Outfall #002			—	0.10+	—	—	6.0-9.0
Hughes Ready Mix		Crooked Creek	—	30	—	—	6.0-9.0

* Limitations data derived from NPDES monitoring reports on file with the Missouri Department of Natural Resources

+ Settleable solids, ml/l

** Not greater than potable water produced

(D) 6.0 mg/l or 80% of saturation, whichever is less

P Streams that maintain permanent flow even in drought periods

P1 Standing-water reaches of Class P streams, including impoundments

C Streams that may cease flow in dry periods, but maintain permanent pools which support aquatic life

Source: Sverdrup & Parcel and Associates, Inc. (1983b)

- City of St. Charles
  - -- Mississippi River Plant
  - -- Missouri River Plant
  - -- St. Charles Trails Plant
  - -- Heatherbrook Lagoon
- City of St. Peters Spencer Creek Plant
- City of Portage des Sioux Septic Tank
- Duckett Creek Sewer District
  - -- Duckett Creek Plant
  - -- Harvester-Dardenne Plant
  - -- Highway 94 - South Plant
  - -- Boschertown Lagoon

Private sanitary wastewater treatment facilities that operate under NPDES permits and discharge directly to streams include:

- Martell Subdivision
- Riverview Hills Subdivision
- St. Joseph Church and School
- Tee Kay Mobile Manor
- Timbercrest Subdivision
- Yacht Club of St. Louis

Industrial dischargers include:

- City of St. Charles
  - -- Main Street Water Treatment Plant
  - -- Elm Point Water Treatment Plant
- City of St. Peters Spencer Creek Water Treatment Plant
- Findett Corporation
- Hitchiner Manufacturing Company
- Hughes Ready Mix

From review of existing NPDES permits in the planning area, Duckett Creek Sewer District's Boschertown Lagoon and Harvester-Dardenne Plant, the City of St. Charles' Heatherbrook Lagoon and St. Charles Trails Plant, and Hitchiner Manufacturing Company must all abandon their wastewater facilities and connect to trunk sewers within 90 days after a trunk sewer is available. Martell Subdivision, Riverview Hills Subdivision, and Tee Kay Mobile Manor have 180 days to connect to trunk sewers once the sewers are available. Some of the individual NPDES permits, especially for the industrial dischargers, may limit other parameters in addition to those listed in Table 2-6.

2.2.1.4 Economic Factors

Economic factors (e.g., capital costs, operation and maintenance costs, present worth, etc.) must be developed in accordance with construction grant regulations and applied evenly to the evaluation of all systems. If systems are developed using a different basis for costs, different discount rates, and different planning (cost amortization) periods, then cost comparisons between systems would not be possible. [Note: Refer to Section 6.0, Glossary, for definition of economic terms.]

In this section, preliminary construction, operation, and maintenance costs for the various wastewater collection and treatment techniques are summarized. All economic analyses were based on a 20-year design period. Projected wasteloads and flows for the year 2005 were used to size sewer lines, pumping stations, and treatment facilities. A discount rate of 8% over a 20-year planning period was used to determine present worth and uniform annual equivalent costs for this economic analysis.*

Gravity Sewers and Force Mains

Costs were developed for gravity sewer lines and force mains for various pipe sizes per foot of installed sewer. Costs were based on the EPA document: Construction Costs for Municipal Wastewater Conveyance Systems: 1973-1977. Costs were updated to January 1983 dollars based on the EPA complete urban sewer system (CUSS) index, and adjusted for the St. Louis area. Further cost adjustments were made to reflect recent St. Louis area bid prices. The costs for each lineal foot of sewer line are total construction costs. Gravity line costs include pipe, trenching and backfilling, standard and drop manholes, street and stream crossings, standard and special bedding, rock excavation, pavement removal and replacement, and utility disconnection and reconnection. Force main costs include pipe, excavation, thrust blocks, cleanout manholes, air release valves, pavement removal and replacement, and utility disconnection and reconnection.

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*The current discount rate is 8 1/8%. Adjustment of economic analyses were not done as the change in the discount rate will not affect the relative ranking of project alternatives.

Pumping Stations

Pump design capacities were based on the projected year 2005 peak flows. Three types of pumping stations were considered in the cost analysis: submersible pumping stations, wet well/dry well pumping stations, and screw pumping stations. Preliminary construction costs were based on three EPA publications: Construction Costs for Wastewater Conveyance: 1973-1977, Innovative and Alternative Technology Assessment Manual, and Cost of Land Treatment Systems. Costs were updated to January 1983 dollars and adjusted to reflect recent bid prices in the St. Louis area. Operation and maintenance costs were based mainly on cost curves from Appendix A of EPA's Innovative and Alternative Technology Assessment Manual and were adjusted to reflect anticipated pumping heads.

Treatment Plants

Cost estimates for treatment systems were calculated using the Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) developed by the EPA and Department of the Army. The computer program enabled analyses of large numbers of wastewater treatment systems. CAPDET was used to screen various wastewater and sludge treatment methods. This screening was done in two steps: (1) without consideration of staged construction and (2) with consideration of staged construction. Each of the 8 preliminary alternatives consists of a different combination of service areas and treatment plant locations. Each alternative contains from three to five treatment plants. A variety of unit processes for each plant were considered in the facilities plan.

A listing of the treatment component options considered at each plant is presented in Table 2-7. Unit processes were arranged in various combinations so that from 3 to 20 treatment schemes were evaluated for each treatment plant. The least expensive treatment scheme for each plant was used to determine the effects of staged construction on the eight alternatives. The costs developed utilized the CAPDET program for the treatment schemes and were combined with the costs for sewers and pump stations. The present worth values for staged construction ranged from $40,000,000 to $64,270,000.

TABLE 2-7
WASTEWATER TREATMENT OPTIONS CONSIDERED
DURING PRELIMINARY COST ESTIMATING

Liquid Line	Sludge Line
Mississippi River Plant	
Bar screen Comminutor Grit Chamber Primary clarifier Step aeration Secondary clarifier Chlorination	Gravity thickener Aerobic digester or anaerobic digester, or incinerator Land application or sludge lagoon
Missouri River Plant	
Bar screen Comminutor Grit chamber Primary clarifier Step aeration, or Contact stabilization or Complete mix, or Plug flow, or Pure oxygen Chlorination	Gravity thickener Haul to Miss. Plant or aerobic digester, or anaerobic digester Land application
St. Peters Plant	
Contact stabilization Nitrification Chlorination	Haul to Miss. Plant or aerobic digester Land application or sludge lagoon
Duckett Creek Plant	
Contact stabilization or Step aeration, or Plug flow, or Oxidation ditch	Haul to Miss. Plant or aerobic digester, or anaerobic digester, Land application or sludge lagoon
Harvester-Dardenne Plant	
Contact stabilization, or Step aeration, or Plug Flow, Nitrification Chlorination	Haul to Miss. Plant or aerobic digester, or anaerobic digester Land application or sludge lagoon

In addition, an analysis was performed on the cost-effectiveness of replacing the Missouri River Plant with a pumping station and force main. Wastewater would be pumped to the Mississippi River Plant for treatment. The present worth analysis indicated that it would be more economical to treat wastewater from the Missouri River service area at a new secondary facility than to construct a pumping station and force main and treat the wastewater at an expanded Mississippi River Plant. Based on this result, pumping the Missouri River Plant wastewater to the Mississippi River Plant was not considered a viable plan. It was also determined in the draft facilities plan that it would be cost-effective to pump the Spencer Creek Plant effluent to the Mississippi River, rather than upgrade the plant to include nitrification (AWT) with the treated effluent discharging into Spencer Creek. An "Advanced Treatment" review by EPA may be required to document the cost-effectiveness of this alternative prior to construction grant award (see memorandum dated 11 January 1985 from Thomas Carter, Chief, EPA, Construction Grants Branch to Ed Vest, Chief, EPA Environmental Review Branch, in Appendix D, Significant Correspondence).

2.2.2 Wastewater Management System Components and Component Options

When standard planning and design information applicable to all systems has been developed (as described in Section 2.2.1) various components of complete sewer systems can be identified and evaluated. System components applicable to the Duckett Creek Facility Plan include flow and waste reduction, collection and conveyance systems, wastewater treatment processes, effluent disposal, sludge treatment and disposal, and onsite systems. These components ultimately are integrated in various combinations to form overall system alternatives for wastewater management in the facilities planning area.

2.2.2.1 Flow and Waste Reduction Measures

A design year peak population such as that discussed previously typically is utilized to determine sewage flow that would be generated by residents within a service area, including flows generated by commercial and industrial facilities. However, before a design flow can be determined, other flows and/or wasteloads must be evaluated to document that proposed treatment facilities would not be treating extraneous flows or pollutants that should not be

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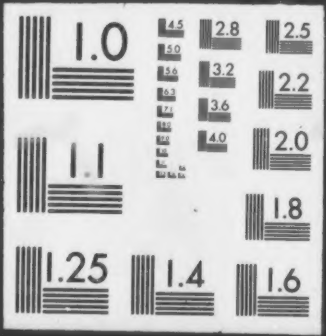
1.0
4.5
5.0
5.6
6.3
7.1
8.0
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

in the sewerage system in the first place. Elimination or reduction of extraneous wastewater flows and wasteloads can substantially reduce the size and costs of new or expanded treatment facilities.

Infiltration/Inflow (I/I) is extraneous rainwater and/or groundwater that finds its way into sewage collection lines. Infiltration consists primarily of groundwater that seeps through loose pipe joints or cracked pipes into sewers, either continuously or over a long duration during and following wet weather. Inflow consists primarily of rainwater that enters sewers through direct connections (e.g., open manholes in drainageways or roof drains illegally connected to the sewer). Infiltration and inflow are considered excessive when the cost for transporting and treating the excess flow exceeds the cost of reducing or eliminating the sources of infiltration and inflow.

The costs for treating extraneous flow were calculated by using the EPA Handbook for Sewer System Evaluation and Rehabilitation, 1975 since recent plant data were not available. The highest infiltration treatment costs were more than $100,000/year for the Mississippi River and Missouri River plants. The highest inflow treatment costs were more than $36,000/year for the same two plants.

Rehabilitation costs contain two components: (1) locating the exact sources of infiltration and inflow, and (2) reducing or preventing infiltration and inflow. The latter component is also called correction or rehabilitation.

Infiltration/inflow is not excessive in the planning area based on EPA Criteria; however, in the St. Peters or St. Charles Mississippi River service areas, open or poorly seated manhole lids should be closed and sealed during routine maintenance operations.

Although combined sewers serve the St. Charles Missouri River service area, the benefit-cost analysis indicated that a program dedicated to separating the sewers is not economical. However, separation performed as part of an infiltration elimination program may be economical.

Currently, several of the treatment plants in the planning area are overloaded or approaching design capacity. Although waste reduction measures may only have a limited effect, concerns over water supply and wastewater disposal and an increasing recognition of the benefits that may accrue through water conservation, are serving to greatly stimulate development and application of water conservation practices. The diverse array of water conservation practices may, in general, be divided into three categories:

- Elimination of non-functional water use;
- Water-saving devices, fixtures, and appliances; and
- Wastewater recycle/reuse systems.

Another possible method for reduction of wastewater flow is adjustment of the price of water to control consumption. Other measures include educational campaigns on water conservation in everyday living, and installation of pressure-reduction valves in areas where water pressure is excessive (greater than 60 psi). Water saving devices must continue to be used and maintained for flow reduction to be effective. City ordinances requiring water saving devices, fixtures, and appliances in commercial establishments (e.g., hotels and motels) and all new residential construction also can be effective.

By utilizing methods to reduce flow or pollutant loads, a wastewater management program can:

- Reduce the size and capital cost of new sewage collection and treatment facilities;
- Delay the time when future expansion or replacement facilities would be needed;
- Reduce operational costs of pumping and treatment;
- Mitigate sludge and effluent disposal impacts;
- Extend the life of existing soils absorption system(s) that currently are functioning satisfactorily;
- Sufficiently reduce wastewater loads to improve failing soil absorption systems in which effluent is surfacing or causing backups; and
- Reduce the size of the soil disposal field required for new onsite systems.

Additional potential benefits of flow reduction to the communities, as well as the usefulness of methods, analysis procedures, and examples are provided in a document entitled Flow Reduction (USEPA 1981).

2.2.2.2 Collection and Conveyance Systems

As with most centralized wastewater management systems, there are various options available for collection and conveyance of sewage. In the Duckett Creek Facility Planning Area three major modes were evaluated in the draft facilities plan--gravity sewers, force mains, and pumping stations. Conventional gravity sewers are designed to collect raw sewage and transport it by gravity flow to a WWTP, interceptor sewer, or pumping station. Small diameter gravity sewers also can be designed to collect septic tank effluent (which contains less solids than raw sewage) and to transport it by gravity flow to a WWTP, interceptor sewer, or pumping station. Further, low pressure sewers consisting of a pump at each connection that pumps wastewater through a small diameter pressure main to a WWTP, interceptor sewer, or pumping station also may be considered. Low pressure sewers can be designed to pump raw sewage (grinder pump system) or septic tank effluent.

Interceptor sewers collect and transport wastewater from a number of discrete areas to a WWTP through trunk gravity sewers, pumping stations, and force mains. Principal conditions and factors that could necessitate the use of pumping stations in the wastewater collection or interceptor system are as follows:

- The elevation of the area to be served is too low to be drained by gravity flows to existing or proposed trunk sewers
- Service is required for areas that are outside the natural drainage area, but within the sewage or drainage district
- Omission of pumping, although possible, would require excessive construction costs because of deep cuts required for installation of a trunk sewer to drain the area.

Pumping stations pump wastewater under pressure through a pipeline referred to as a force main. For purposes of economy, force main profiles generally conform to existing ground elevations. For the planning area, the major differences among these systems would be in the layout configurations, and sizes and lengths of pipe.

2.2.2.3 Wastewater Treatment Processes

A variety of treatment processes were considered in the Facility Plan.

In general, wastewater treatment options include conventional physical, biological, and chemical processes and land treatment. Conventional options utilize preliminary treatment, primary treatment, secondary treatment, and advanced treatment. These unit processes typically are followed by disinfection prior to effluent disposal. Land treatment processes which achieve advanced treatment levels include slow-rate infiltration or irrigation, overland flow, and rapid infiltration.

The degree of treatment required often is dependent on the effluent disposal option selected (Section 2.2.2.4). Where disposal of treated wastewater is by effluent discharge to surface waters, effluent quality limitations (Section 2.2.1.3) establish the required level of treatment.

Preliminary Treatment and Primary Sedimentation

All conventional sewage treatment options considered in the draft facilities plan incorporate preliminary treatment and primary sedimentation. These unit processes serve to remove coarse solids, readily-settleable suspended solids (TSS), floating solids, and grease from influent wastewater. Preliminary treatment generally consists of a bar screen (a screening device) or a combination of a coarse bar screen and a comminutor, followed by a grit chamber. Solids are ground in the comminutor and left in the waste, thereby eliminating the separate disposal of screenings. A grit chamber is used for removal of inorganic solids such as sand. The next treatment unit is a primary sedimentation tank, in which heavy solids settle and light solids float. Sludge (settled solids) and scum (floating solids) are removed to solids (sludge) handling facilities. Clarified liquid then flows out of the primary sedimentation tank to subsequent treatment units. Typically, these processes will remove approximately 30% of the BOD_5 and about 50% of the TSS from wastewater (USEPA 1980a).

Secondary Treatment

Secondary treatment typically consists of biological processes in which soluble and colloidal-sized organic substances are removed from wastewater. The most frequently used processes provide a fluid media such as the oxidation ditch and the activated sludge process, or a fixed media such as the trickling filter, rotating biological contactor (RBC), or activated biological filter (ABF) process. Ten processes were selected for analysis in the draft facilities plan, and for comparative purposes, a brief discussion of each process is presented below. These systems are described in more detail in the facilities plan (Sverdrup & Parcel and Associates, Inc. 1983b).

> Activated sludge consists of an aerated suspension of microorganisms that utilize organic wastewater for respiration and reproduction. Aeration generally is provided by diffusion of air from the bottom of the tank or mechanical agitation of the surface. Separate settling facilities are used to remove viable organisms from the treated wastewater. There are a number of modifications to the basic activated sludge process, each specific to a different strength of waste. Efficiencies of BOD removal by primary treatment and conventional diffused air and pure oxygen options typically range from 85 to 95% (USEPA 1980a).
>
> The complete mix modification of the activated sludge process involves almost instantaneous mixing of the influent wastewater throughout the aeration tank. Generally, mechanical aerators are employed to supply air and to mix the reactor basin contents, although diffused air can be used. Detention time is about 5 hours and organic loading ranges from 35 to 50 lbs per 1,000 cu ft of reactor basin volume. Advantages of the complete mix system include low air requirements and the ability to resist shock loadings. The major disadvantages are the use of mechanical aerators which can cause operational difficulties, particularly in cold weather, and the high capital cost.
>
> The step aeration modification of the activated sludge process consists of introducing the influent wastewater at two or more points in the reactor basin. Air requirements are distributed more evenly over the length of the tank, and the system is more capable of withstanding shock loads. Organic loading can be increased to 50 lbs per 1,000 cu ft and detention time can be decreased to 5 hours. This reduces the reactor basin volume. In addition, air requirements are reduced. With proper design, a step aeration system can be operated in both the conventional and step aeration modes, which provides added flexibility. The disadvantages are the same as those for the conventional process, but to a lesser extent, plus a higher capital cost to provide the piping and meters to distribute the influent flow to more than one point.
>
> The pure oxygen activated sludge process utilizes a multistage, covered reactor basin. For a large plant, oxygen is generated onsite and is supplied to the first stage of the reactor basin. Oxygen feed is regulated by maintaining a constant gas pressure within the tanks. The oxygen is transferred to the water by mechanical agitators. As the wastewater flows from stage to stage, oxygen is gradually utilized and nitrogen gas and carbon dioxide are produced. By the time gases are vented to the atmosphere in the final stage, less than 10% of the oxygen remains, resulting in over a 90% utilization efficiency. Advantages of the pure oxygen system include low power costs, a more concentrated sludge, a short (2-hour) detention time

resulting in smaller aeration tanks, and the ability to tolerate shock loads. Disadvantages of the pure oxygen system include higher capital costs, higher maintenance costs, danger of fire or explosion in a pure oxygen environment, and reduced effluent pH (more acidic) due to a high concentration of carbon dioxide.

A *contact stabilization* activated sludge process consists of a contact tank with a detention time of 1 to 2 hours, followed by a sludge re-aeration tank with a detention time of 3 to 6 hours. Organic matter in the wastewater is adsorbed by the activated sludge floc in the contact tank. After clarification, the sludge is returned to the stabilization tank where organic matter in the sludge is oxidized. The "stabilized" sludge is then returned to the contact tank or wasted. Advantages of the contact stabilization process include reduced tankage volume compared to a conventional activated sludge system. In addition, primary treatment is not required, although the efficiency of the process suffers as a result of eliminating primary treatment. Disadvantages of the process include high air requirements and the production of excessive quantities of sludge, particularly when primary treatment is not employed.

One of the most common fixed-media treatment systems is the *trickling filter*. A trickling filter consists of a tank filled with large rock or plastic media with a drain system on the bottom. As sewage passes through the media, biological organisms as they grow and reproduce degrade organic material in the wastewater. Treated wastewater along with excess biomass (waste organisms) is drained to separate settling facilities. Efficiencies of BOD removal by trickling filters typically range from 70 to 85% (USEPA 1980a).

Rotating biological contactors (RBC) are recent advances in fixed-media-type treatment systems. This system is more compact than conventional rock trickling filter systems. RBCs consist of a fixed medium (disks) on which biological growth develops. The disks rotate partially submerged in wastewater. Separate settling facilities are used to remove slough (excess biomass) from treated wastewater. The efficiency of the RBC process is comparable to that of activated sludge (i.e., 85 to 95%).

An *oxidation ditch* system typically consists of an oval tank that employs the extended aeration activated sludge (aerated suspension) process followed by separate settling facilities. Typical BOD removal ranges from 85 to 95%. Because of long detention times, oxidation ditches normally are not economical or cost-effective for treating flows greater than 10 mgd.

Physical-chemical processes utilize chemical addition and flocculation, sedimentation, and possibly filtration for the removal of suspended solids, suspended BOD, and some dissolved inorganics such as phosphorus. Dissolved organics can then be adsorbed on activated carbon. Chemicals are added for suspended solids and phosphorus removal and polymers are normally added to improve settling. Phosphorus removals of 90% and suspended solids removals of 75% may be obtained quite readily with this process. Activated carbon can be used to increase BOD removal and to remove certain toxic materials.

Advantages of the system include good effluent quality, the ability to handle shock loads, and the ability to treat toxic material. BOD and suspended solids removals of 80-90% percent are common and can reach 95%. This system, when properly designed, is quite tolerant of fluctuations and shocks from organic and hydraulic loadings that often cause upsets in biological treatment systems. In addition, most toxic materials that may seriously upset a biological system are removed. For these reasons, physical-chemical treatment may be advantageous for systems receiving industrial wastes. Normally, this system is economically feasible only when effluent requirements dictate a tertiary treatment level, including phosphorus removal. Operation and maintenance costs are high, control of the process is difficult, and larger quantities of sludge are produced.

Ponds or lagoons are classified according to the type of biological activity that takes place. General classifications include aerobic, aerobic-anaerobic (facultative), and anaerobic. Aerobic and facultative ponds may or may not include aeration facilities. Aerobic ponds are those in which aerobic conditions are maintained throughout. Aerobic ponds utilize oxygen transferred from the atmosphere, usually assisted by mechanical means (aerators or blowers). In a non-aerated pond, there is a mutually beneficial (symbiotic) relationship between the algal population and the aerobic bacterial population. Through photosynthesis, algae utilize carbon dioxide and sunlight as food and energy sources and release oxygen as a by-product. This oxygen is utilized by the aerobic bacterial population. The carbon dioxide utilized by the algae is supplied as a by-product of bacterial oxidation and by atmospheric carbon dioxide. In this process, the inorganic carbon in carbon dioxide is converted to organic carbon compounds that are incorporated into the algal cell mass, contributing to the BOD. Typically, 80 to 95% of BOD is removed by aerobic pond treatment.

Facultative ponds may or may not be aerated, and consist of three treatment zones: a surface aerobic zone, an anaerobic bottom zone, and an intermediate zone that is partially aerobic and partially anaerobic called the faculative zone. The aerobic zone functions as an aerobic pond, with oxygen supplied either by aeration, or by algal photosynthesis. Solids settle to the bottom zone where they are degraded anaerobically, with gaseous and liquid products of anaerobic decomposition being carried to the aerobic zone by mixing currents where they are aerobically oxidized, thus minimizing odor problems. BOD removals in facultative ponds generally range from 70 to 95%.

Anaerobic ponds generally are relatively deep, and are anaerobic throughout their depth except for a very shallow surface zone. Normal removals of organics in anaerobic ponds are not as high as may be required to meet effluent standards. BOD removals average about 70%, with 85% maximum under optimum conditions. Anaerobic ponds normally are quite odorous because the end products of anaerobic decomposition are released directly to the atmosphere. Because of the low BOD removals, anaerobic pond effluent is normally treated in an aerobic pond prior to discharge. The major advantage of lagoons is the low capital cost. Disadvantages of ponds or lagoons include the fact that effluent BOD and suspended solids concentrations will not consistently meet secondary treatment removal efficiencies. In addition, land requirements are extensive for a lagoon treatment system, and provisions to prevent groundwater contamination are required. Odors can also result from lagoons, particularly during the early spring when the contents "turn over" due to melting ice and destratification.

Secondary Clarification

Following biological treatment, suspended solids are normally separated from treated wastewater using sedimentation. Clarification will be accomplished in circular tanks and generally should provide a good separation of solids and treated wastewater. Circular tanks are the most common because they provide good separation of solids and treated wastewater.

Nitrification

Advanced treatment involves "polishing" (i.e., the additional treatment of) treated wastewater beyond primary and secondary processes. Advanced treatment processes may include physical filtration, chemical treatment, and biological nitrification/denitrification.

Often, advanced treatment is needed to reduce excess concentrations of nitrogen, phosphorus, and other nutrients in wastewater that can cause undesirable biological growths (algal blooms) and/or significant depletions in levels of dissolved oxygen in rivers and lakes. Most biological nitrification/denitrification systems and chemical treatment systems are designed to remove these excessive amounts of nutrients. Biological nitrification is similar to secondary biological treatment, but relies on a special group of autotrophic bacteria which derive the carbon required to synthesize cellular material from inorganic carbon dioxide. Biological nitrification is usually preceded by treatment designed to achieve partial BOD removal.

Because of their slow reproduction rate, sufficient numbers of nitrifiers must be retained in the nitrification unit for a relatively long period. This requires recirculation of sludge to the inlet end of the nitrifying unit. Nitrification should occur in well-designed and operated extended aeration type activated sludge plants provided the liquid temperature remains above 5°C (40°F). Construction below ground would help maintain adequate liquid temperatures in winter.

Disinfection

Disinfection is the process of destroying pathogens, including viruses, and other harmful microorganisms. Chemical agents are most commonly used to disinfect wastewater, although disinfection can also be accomplished using radiation, ozonation, mechanical means, and physical agents. Of the various possible methods of effluent disinfection, only chlorination is widely used for wastewater treatment.

Ideally, wastewater disinfection kills or inactivates the pathogens present and does not continue its action beyond the treatment facility. The efficiency of chemical disinfection is primarily dependent on the adequacy and rate of mixing, contact time, concentration of disinfectant, temperature of water, efficiency of residual control system (if applicable), pH, concentration of interfering substances, and quality of operational surveillance. Of these variables, the mixing, concentration of disinfectant, contact time, and residual control system are the ones primarily affected by a facility design. There are, however, important precautions necessary when using chlorine. It is a dangerously toxic gas and highly corrosive in the presence of moisture. Preventive maintenance to preclude the possibility of leaks is most important.

Dechlorination, if required, can be accomplished with reducing chemicals (such as sodium bisulfite, hydrogen peroxide, sulfur dioxide, sodium sulfite, or sodium thiosulfite) or with beds of activated carbon. Each dechlorination system requires some additional equipment and possible pumping.

2.2.2.4 Effluent Disposal Methods

Three basic effluent disposal techniques were considered for use in the Duckett Creek Planning Area: land application of effluent, effluent reuse, and effluent discharge to surface waters. Deep well injection was not considered to be a viable or cost-effective alternative for effluent disposal in the planning area because of economics and geological conditions.

Land Application

Land application is a treatment technology that often replaces conventional secondary and advanced treatment technologies. Land treatment of wastewater utilizes natural physical, chemical, and biological processes in vegetation, soils, and underlying formations to renovate and dispose of domestic wastewater. Land application methods have been practiced in the United States for over 100 years and presently are being used by hundreds of communities throughout the Nation (Pound and Crites 1973). In addition to wastewater renovation, advantages of land treatment may include groundwater recharge, soil conditioning, and augmented plant growth. Applicability of this treatment option depends significantly on social acceptance, costs, and the amount of energy required to transport sewage to the treatment site. The three principal processes utilized in land application of wastewater include: (1) overland flow; (2) slow rate irrigation; and (3) rapid infiltration.

> In the overland flow process, primary or secondary treated wastewater is allowed to flow over a sloping surface and is collected at the bottom of the slope. This type of land application system usually is followed by discharge of effluent to a receiving stream. Overland flow generally results in BOD and TSS removal efficiencies of 90 to 95%. Phosphorus removal usually ranges from 30 to 60%. Only moderate land acreages are required for overland flow systems, because application rates of wastewater range from 4 to over 10 inches per week (in/wk) (USEPA 1980a). A well-designed and properly operated overland flow system potentially would achieve the anticipated 10/15 effluent limitations.
>
> In the slow rate irrigation method, primary or secondary treated wastewater is applied to land to enhance growth of crops or grasses. Wastewater is applied by spray, ridge and furrow, or flood methods, depending on soil drainage characteristics and type of vegetation. Application rates range from 0.5 to 4.0 inches per week. Final renovation of wastewater occurs in the first 2 to 4 feet of soil, as organic matter, phosphorus, heavy metals, and bacteria are retained by adsorption and other mechanisms. Nitrogen is taken up by plants as they grow, and removals may be as high as 90%. Water is lost from the system through deep percolation and evapotranspiration. The probability of affecting groundwater quality is moderate, and a minimum depth to groundwater of 5 feet is recommended (USEPA 1977). Large amounts of land are needed for the slow rate process, but the land remains in normal agricultural or silvicultural production.
>
> The rapid infiltration method involves application of wastewater at high rates (4 to 120 in/wk) to soils with high permeablity such as sands and loamy sands. Although vegetation cover may be present, it is not an integral part of the system. Cleansing of wastewater occurs within the first few feet of soil by filtering, adsorption, chemical precipitation, and other geochemical reactions. In most cases, TSS, BOD, and fecal coliform organisms are removed almost completely. Phosphorus removal can range from 70 to 90%, depending on physical and chemical properties of soils. Nitrogen removal generally is less significant, unless specific procedures are established to maximize denitrification (USEPA 1977). In rapid infiltration systems, there is little or no consumptive use of wastewater by plants, and only minor evaporation occurs. Because most of the wastewater infiltrates into the soil, groundwater quality may be affected. To minimize the potential for groundwater contamination at a rapid infiltration site, the minimum depth to the water table should be 10 feet. Due to extremely rapid rates of infiltration, permeability of the underlying aquifer must be high to ensure that the water table does not mound significantly and limit operations on site.

Major factors in assessing the suitability of land treatment in the Duckett Creek Planning Area are the land-intensive nature of this type of treatment and the rapidly growing residential development in the "Golden Triangle." Residential land would be very expensive and use/purchase of these lands would likely run into strong local opposition. The only area reasonably considered in the draft facilities plan for land treatment is agricultural land in the Mississippi River floodplain.

Soils in the Mississippi River floodplain are generally of the poorly-drained clay types, except for the Haynie-Blake-Waldon and Lomax-Blase associations (Figure 3-2). The water tables in the floodplain are shallow and slopes range from 0 to 2%. The rapid infiltration method was ruled out due to the low permeability of the soil. The overland flow method was eliminated because of level topography. The slow rate land treatment method is the most appropriate for the floodplain area, but a majority of the open farmland that may be available for land treatment consists of poorly-drained soils, not conducive to wastewater percolation.

Effluent Reuse

Three uses of renovated wastewater, industrial process water supply, groundwater recharge, and irrigation were considered in the draft facilities plan. Since the Mississippi River and Missouri River are nearby, there is no need for additional water for groundwater recharge, and St. Charles County is not considered arid, so there is no need for arid land development.

Industries in the planning area use relatively small quantities of process water. Because high quality water is generally required, it is more economical for industry to obtain process water from utilities than to install and operate advanced water treatment systems. Further, if wastewater treatment could provide acceptable water quality for industrial purposes, only 4% of the wastewater discharged could be utilized by the current industrial demand. Therefore, wastewater reclamation and reuse was not considered a viable alternative primarily because of the lack of an end use for the renovated wastewater.

Discharge to Surface Waters

If effluent is discharged to surface waters, wastewater must be treated to a level that conforms to applicable state and Federal discharge limitations. Discharge limitations are based on the uses and assimilative capacity of the receiving water and the quantity of effluent to be discharged. Factors such as flow, oxygen content, and reoxygenation capacity of the receiving stream are considered in establishing effluent limits. Treatment processes considered in the facilities plan for WWTPs discharging to surface waters included physical/chemical treatment and a number of physical/biological treatment systems.

2.2.2.5 Sludge Treatment and Disposal Methods

Sludge treatment and conditioning methods depend largely on the choice of the ultimate sludge disposal method. Therefore, in the facilities plan, ultimate sludge disposal options were considered before evaluating stabilization options.

Ultimate Sludge Disposal

Ultimate sludge disposal options considered included land application, sanitary landfills, and incineration. Incineration is discussed in the sludge stabilization processes section.

- Land Application -- For the purposes of this discussion, land application is differentiated from landfill disposal by the fact that land application is a surface disposal method whereas landfill is a burial technique. Land application usually utilizes stabilized sludge as a soil conditioner. Liquid sludge, sludge cake, or dried sludge can be applied and, normally, the sludge is tilled into the soil after application. Land application is a relatively inexpensive method of disposal if suitable sites are available and, especially, if liquid sludge applications are used, thus eliminating costs of dewatering and related treatment.

- Sanitary Landfill -- Stabilized or non-stabilized sludge may be disposed of by landfill. Normally, regulations require dewatering prior to deposition in a sanitary landfill. Depending on regulations, the sludge may be mixed with refuse or may be deposited in a separate area of the landfill. Operation of the landfill site must meet all regulations of applicable authorities. The major costs associated with landfilling sludge include transportation and landfill operation and maintenance.

- Sludge Dewatering -- Sludge dewatering systems compared in the facilities plan included vacuum filtration, centrifugation, pressure filtration, use of belt filter presses, and drying beds. The first four methods are types of mechanical dewatering systems that dewater sludge on a regularly scheduled basis, with modest space and labor requirements. Disadvantages include sludge conditioning requirements, capital cost of the dewatering and auxiliary equipment and structures to house the equipment, relatively complex operation and maintenance of the equipment, and high energy input into the dewatering system compared to drying beds. One auxiliary item required with all dewatering equipment is a sludge storage area.

  -- Vacuum filtration is probably the most widely utilized method of mechanical sludge dewatering. The major problem associated with vacuum filtration is that the air discharged from the vacuum pump is quite odorous. Also, performance is very sensitive to incoming feed characteristics and operating costs for labor, maintenance, and energy are comparatively high.

  -- Centrifugation utilizes the centrifugal force generated by a spinning bowl to separate solids from liquids. The primary problem associated with the system mechanics includes rapid wear from grit and vibration. Cake conveyance also must be provided and labor and energy costs are generally high.

  -- Pressure filtration utilizes a batch operation as opposed to the continuous operation of a vacuum filter as in centrifugation. The major advantage of a filter press is that chemically conditioned sludge can be dewatered to over 50% solids.

  -- Belt filter presses are becoming increasing popular at wastewater treatment plants. Power requirements are low, labor requirements are reasonable, and high cake solids can be attained. A disadvantage may be short filter cloth life. Also, performance is quite sensitive to incoming feed characteristics.

  -- Drying beds, typically are utilized for stabilized sludge (generally digested) with no conditioning. Drying beds are generally easy to maintain and operate and function quite well with little operator attention. The primary disadvantage to drying beds is the large land area required. Sludge drying beds are usually considered uneconomical for WWTPs serving over about 20,000 people.

- Sludge Stabilization -- Sludge stabilization methods considered in the facilities plan included heat treatment, lime treatment, composting, anaerobic digestion, aerobic digestion, and incineration. A well-stabilized sludge is required to prevent potential odor problems and health hazards.

  -- Heat treatment consists of subjecting the sludge to elevated temperatures (300 to 500°F) and high pressures (150 to 400 psi) for short periods of time (15 to 60 min). This creates a sludge that is sterilized, deodorized, and that dewaters well. The process consumes significant amounts of energy, is complex to operate and maintain, and creates a high-strength waste liquor that exerts a significant load on the treatment facilities when recycled.

-- Lime treatment consists of adding lime to the sludge to raise the pH above 10. At this pH, microorganisms will not grow rapidly, so organic decomposition and resulting odors are reduced. Lime treatment increases the volume of sludge requiring disposal. Ultimate disposal alternatives are also limited when lime is added to the sludge.

-- Composting is an aerobic biological stabilization and drying process in which organic sludge solids are oxidized by bacterial action. The operation produces a well stabilized sludge which can provide nutrients to soil and increase crop productivity. Disadvantages of a composting operation include high operating costs and the need to develop a market or other outlet for the composted sludge.

-- Anaerobic digestion stabilizes sludge by converting about half of the organic matter to carbon dioxide and methane gas through bacterial action. The methane gas can be used to heat the digester and buildings, to power equipment, and to mix the digester contents. If operated properly, gas from an anaerobic digester can meet up to 70% of the treatment plant's total energy requirements, depending on the treatment process. The major disadvantages of an anaeorbic digester are high capital costs and operational difficulties.

-- Aerobic digestion consists of oxidizing organic matter in sludge to carbon dioxide and water by bacterial action in an aeration tank. A well-stabilized sludge is produced after a 15- to 20-day detention time. The process is easy to operate and maintain. The major disadvantage of the process is the high energy consumption required to supply oxygen to the system, particularly when primary sludge must be digested.

-- Incineration requires prior sludge dewatering with the sludge cake being fed to the incinerator at a controlled rate. Incineration systems generally are utilized in larger treatment systems where the handling of the reduced volume of ash can offset the capital and operating expenses of the incineration system. Capital costs are quite high and depending on the amount of auxiliary fuel required, operating costs also may be high. The various components of the system have a relatively large electrical consumption. Incineration systems generally require a considerable amount of maintenance and require a high quality of operation.

2.2.2.6 Onsite and other Small Community Systems

Many rural areas in the Duckett Creek Planning Area are not served by a public sewer system and not expected to be served by systems in the foreseeable future. This is especially true for areas in the Mississippi River floodplain. These areas have individual treatment systems (i.e., onsite systems) that consist of septic tanks and soil absorption fields, many of which show evidence of failure. Onsite system failures result in foul odors and frequent surface discharges, creating a potential health hazard to residents. Treatment methods for such areas include various types of onsite systems or small localized collection and treatment systems. A discussion of these methods follows.

Septic Tank and Soil Absorption Field

Typically, a 4-inch polyvinyl chloride (PVC) pipe or vitrified clay pipe carries household wastewater to a septic tank. A household septic tank is usually about 1,000 gallons in capacity and constructed of precast concrete or fiberglass. Bacterial digestion of solids occurs slowly in the tank and the residue (septage) must be removed every few years. The liquid portion flows to a subsurface drainage system, where it percolates into the soil. Bacteria in the soil work to further purify the wastewater.

Septic tanks and soil absorption fields are widely used and very acceptable if constructed in suitable soils and properly maintained. Such systems have low initial costs and are easy to maintain. The major limitations of these systems are associated with poor soils, an insufficient absorption area, steep slopes, high water tables, or shallow soils over bedrock.

The major consideration for soil absorption systems is proper design and construction for the soil conditions on the individual parcels. In areas where a number of people would be exposed to effluent from a failed system, special care should be taken to ensure that the system will operate properly. Government agencies are best suited to accomplish this task. Seepage trenches (drainfields) should be used and sized according to the permeability of the soil. The major limitation of the problem areas on the uplands is slope. Special designs must be used so that the effluent is distributed evenly. Also, upslope subsurface drainage must be removed with curtain drains on many parcels.

The town of Kampville and the subdivision near Portage des Sioux have soils that are unsuitable for onsite systems except with unusual design solutions. Because many of these may be seasonal residences, the design of these is less critical than for a permanent residence. Waste segregation, blackwater holding tanks, curtain drains, and mound soil absorption systems in conjunction with extensive household water conservation measures may be effective on a limited basis in preventing surface discharge of septic tank effluent.

Aerobic Tank and Soil Absorption Field

Aerobic tanks are underground units that provide mechanical aeration of wastewater. Aerobic bacteria grow and break down the waste materials more rapidly and completely than in septic tanks. The treated water usually goes to soil absorption fields for final treatment and disposal. Initial purchase costs and operation and maintenance costs for these systems are higher than those for conventional septic tanks. Odor potential is reduced with aerobic systems if surfacing problems occur. The limitations of these systems are similar to the limitations for septic tanks.

Mound Systems

Mound systems are used in conjunction with septic tanks or aerobic tanks. The mound is constructed of sand built up to 2 to 4 feet above the original ground level. The septic tank effluent is pumped to a mound absorption field, and distributed through the mound by a perforated pipe. Mound systems may be effective in areas where the groundwater or bedrock is shallow, or in areas with low soil permeability. Initial costs for mound systems are higher than conventional soil absorption systems, especially when pumping is required.

Conventional Gravity Sewers

Conventional gravity sewers are the most universally applied means of collecting and transporting wastewater. Depending on the terrain, pumping stations may be required. Developed areas would require deep cuts through yards and streets and across utilities, making construction difficult. Shallow bedrock and high groundwater conditions can add to the construction cost of gravity sewers. Gravity sewers are routinely constructed in new developments.

Small-Diameter Gravity Sewers for Septic Tank Effluent

Small-diameter gravity sewers are similar to conventional sewers, except the minimum pipe diameter is smaller, thus saving initial material costs. While conventional sewers normally have 8-inch diameter collector pipes as a minimum size, small-diameter systems usually employ 4- or 6-inch diameter pipes.

Pressure Sewers

There are two types of pressure sewer systems--septic tank effluent pumps (STEP) and grinder pumps (GP). STEP units utilize existing septic tanks. The shallow pipe depth allows for construction simplicity and economy. Inflow and infiltration, which are a factor in gravity sewers, are less of a factor in a pressurized sewer. Septic tanks still require maintenance, including periodic septage removal. Operating costs of a STEP system are typically higher than costs for a similar sized gravity sewer.

GP units do not utilize septic tanks, instead waste goes into a holding tank which houses a submersible grinder pump. Solids are cut into smaller pieces by a grinder pump prior to being pumped through a 1-or 2-inch PVC pipe. Advantages are similar to the advantages of a STEP system. Grease and fiber may accumulate in GP pressure sewers and cause clogging. GP units are more expensive to purchase and operate than STEP units.

The residences in the Mississippi River floodplain, with the exception of Portage des Sioux, rely on onsite systems for wastewater treatment. Approximately one-half of residences in the floodplain areas are occupied seasonally (by telephone, Roger Dunajeik, St. Charles County Health Department, to WAPORA, Inc., 19 April 1984). The subdivisions and communities that have the highest density and number of residences are Alton Lake Estates, Woodland Harbor, South Shore, and Peruque on the river and Orchard Farm, Prairie Homes, and Kampville away from the river. Some smaller concentrations of residences also are present.

The majority of the residences utilize septic tank and soil absorption systems. The onsite systems in the floodplain frequently experience failures and are considered to be unsatisfactory as a treatment method as they are currently constructed for most areas. In the respective areas, the individual residences would need to be surveyed to determine whether or not the existing system is adequately serving the residence, especially since the wastewater treatment needs of a seasonally occupied residence is different from a permanently occupied residence.

In the Facility Plan the only alternative considered was conventional gravity collection systems and treatment at an existing or proposed facility. Small, local treatment facilities were considered unfeasible because about 12 small package plants would entail an excessive operation and maintenance burden on a sewer district and local community. Also, the proposed Portage des Sioux facility and the Mississippi River plant can accommodate the additional flows.

A network of pumping stations and force mains would be necessary to transport sewage to the two treatment plants. A preliminary layout of collection sewers, pumping stations and force mains is shown in Figures 2-12 and 2-13 (pages 2-78 and 2-79, respectively). This alternative would involve a high commitment to maintaining the communities in the floodplain.

2.2.2.7 Innovative and Alternative Treatment

Innovative and alternative (I/A) municipal treatment technology represents an advancement in state-of-the-art technology with respect to meeting the specific national goals of: (1) greater recycling and reuse of water, nutrients, and natural resources; (2) increased energy recovery and conservation, reuse, and recycling; (3) improved cost-effectiveness in meeting specific water quality goals; and (4) improved toxics management.

A monetary incentive is offered for I/A treatment technologies by providing a Federal grant increase from 55% to a total of 75%. For conventional concepts of treatment, innovative technology must meet a 15% life cycle cost reduction or a 20% net primary energy reduction over non-innovative alternatives. The criteria for qualifying alternative technology as innovative include the above-mentioned goals plus improved operational reliability, improved environmental benefit, and improved joint industrial and municipal treatment potential.

Treatment systems and unit processes specifically identified as alternative technologies include the following:

- land treatment
- aquifer recharge
- aquaculture
- silviculture
- direct reuse (not potable)
- horticulture
- revegetation of disturbed lands
- containment ponds
- treatment and storage prior to land application
- preapplication treatment
- land application of sludge
- sludge composting prior to land application
- sludge drying prior to land application
- co-disposal of sludge and refuse
- anaerobic digestion with greater than 90% methane recovery
- self-sustaining incineration
- onsite treatment
- septage treatment
- alternative collection systems for small communities, including pressure sewers, vacuum sewers, and small-diameter gravity sewers

Several of these treatment technologies were investigated during the preliminary screening and in the Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) analysis in the facilities plan. Land treatment and reuse of effluents were eliminated from consideration in the facilities plan and sludge composting prior to land application was also considered to be nonfeasible. Sludge drying prior to land application, anaerobic digestion, and self-sustaining incineration were considered in the CAPDET analysis and were found to be cost-effective in some cases. The facilities plan stated that individual and localized systems would be investigated for the outlying communities located in the Mississippi River floodplain, but no specific plans have been developed for inclusion in this EIS.

Many potential innovative and alternative treatment systems that increase energy conservation or improve cost-effectiveness generally were judged in the draft facilities plan to be more applicable to small flows (less than 1 mgd) and therefore were not considered as applicable to this project; however, it should be noted that EPA acknowledges no threshold limit above which I/A solutions need not be considered. Most I/A treatment options for flows of 5 mgd or higher showed low potential for successful application based on the evaluations in the draft facilities plan. These systems included aquaculture, counter-current aeration, and a number of patented package systems. Systems given further consideration in the facilities plan included anaerobic systems, biological aerated filters, and sequencing batch reactors.

- Anaerobic Treatment -- Anaerobic treatment of municipal wastewater is in the experimental stage. There are two basic types currently in use for high-strength industrial wastewaters: fixed bed and fluidized bed reaction chambers. In general, after screening and grit removal, wastewater flows into an enclosed upflow reactor that contains either a plastic fixed media or a fluidized sand bed. Biological growth occurs on the media and treatment or stabilization results from thermophilic anaerobic digestion of organic wastes. The optimum temperature range for the process is 28 to 39° C (82 to 102°F). A byproduct of bacterial respiration is methane gas. The methane is collected and used as an energy source to heat the influent wastewater or to power the upflow pumps. It also is common to recycle a portion of the flow through the anaerobic reactor. Typically, anaerobic treatment does not treat wastewater to secondary treatment levels (30 mg/l BOD and 30 mg/l TSS) and a polishing filter is required. Anaerobic treatment of municipal wastewater has potential for wide scale use. Energy savings are significant. Previous studies (USCOE 1981) have found that anaerobic treatment for a 1 mgd facility would produce more energy than required to operate the plant, however, the process has not been demonstrated on a full scale project, although a 50,000-gpd anaerobic system for Knoxville, Tennessee is planned. The Knoxville project would emphasize the evaluation and refinement of design and scale-up parameters, the development of optimal operating practices, and the demonstration of commercial credibility for small-scale systems. Currently, anaerobic treatment of municipal wastewater is based on technology that is not yet fully developed and therefore was judged to have an unacceptable risk for further consideration in this study.

- Biological Aerated Filter -- The biological aerated filter (BAF) is a down-flow, high rate, fixed film, biological wastewater treatment system. The process removes both soluble and suspended organic material from the wastewater. Primary effluent enters the BAF and flows downward through a packed bed of granular media which provides a surface for biological growth. Air is introduced directly into the packed bed, countercurrent to the wastewater flow, to provide oxygen for the microorganisms. BOD adsorption/oxidation and solids filtration are accomplished in the upper portion of the bed. The bed volume below the level of air injection is undisturbed and serves as a polishing zone for the removal of suspended solids. This may eliminate the need for a separate secondary clarifier. Excess biological growth and trapped suspended solids are removed from the BAF by periodic backwashing of the entire media with treated effluent. An air scour is used at the bottom of the bed to aid backwashing. The dirty backwash water is returned to the primary clarifier. The BAF system is capable of producing a high quality effluent and eliminates the need for secondary clarifiers; however, there is lack of full-scale operational experience in the United States. Only pilot tests and a 0.5 mgd EPA demonstration project have been performed. The BAF system does shows promise as a secondary treatment process and potential cost savings may be realized if no secondary clarifiers are necessary. However, owing to the low stage of technological development and the associated risk, BAF was not recommended as a viable secondary treatment alternative in the facilities plan.

- Sequencing Batch Reactors -- Sequencing batch reactor (SBR) technology involves treatment of wastewater on a batch basis and is simply an activated sludge system in which all steps of the process take place, sequentially in the same tank instead of using separate tanks for each unit process. A typical SBR operation involves (1) filling a tank with raw wastewater or primary effluent, (2) aerating the wastewater to convert the organics into microbial mass, (3) providing a period for settling, (4) discharging the treated effluent, and (5) providing an idle period between tank discharge and refilling (a multiple tank system is required). A key element in the SBR process is that a tank is never completely emptied. A portion of the settled solids remains in the tank for the next cycle. The retention of sludge within the tank establishes a population of microorganisms uniquely suited to treating the waste. During the process, the microorganisms are subject to periods of high and low oxygen and food availability. These conditions develop a population of organisms which is very efficient at treating the particular wastewater. A full scale demonstration plant is operated in Culver, Indiana and performance data show excellent treatment. SBR capital and operation and maintenance costs are reported to be lower than conventional activated sludge systems, and competitive with oxidation ditches. However, while the SBR process offers advantages, operational experience is limited and potential cost savings do not appear to be a significant factor when compared to oxidation ditches. Therefore, sequencing batch reactors were not recommended for further consideration as a secondary treatment alternative in the facilities plan.

2.3 Identification and Selection of Wastewater Management System Alternatives Presented in the Facility Plan

Preliminary alternatives for collection and treatment of wastewater in the Duckett Creek Planning Area were identified by selecting various options for each of the major components described in Section 2.2.2. A more detailed description of the treatment processes considered, costs of liquid treatment and solids handling options, land requirements, energy consumption, personnel requirements, system reliability, and other factors pertaining to the preliminary systems are contained in the "Draft 201 Facility Plan for the Duckett Creek Study Area" (Sverdrup & Parcel and Associates, Inc. 1983b).

Descriptions of the eight (8) preliminary interceptor sewer system configurations, the wastewater treatment and disposal system options, and the screening process used to select the more favorable combinations of options, are given in the following sections.

2.3.1 Description of Preliminary Alternatives

2.3.1.1 Interceptor Sewer System Configurations

The facilities plan included an investigation of eight interceptor sewer system configurations. Other alternatives were solicited from the Advisory Group; however, no additional configurations were suggested. The eight alternatives provide a network of sewers that transport wastewater from the six sewer service subareas, identified in Figure 2-1, to specific sewage treatment plants (STPs). Tables 2-8a-h summarize the eight preliminary alternatives considered in the facilities plan. The alternatives are illustrated in Figures 2-4 through 2-11.

Some elements that are common to each alternative include the eventual abandonment of five STPs and six pump stations after construction of new interceptor sewers. The five STPs include: Highway 94-South STP, St. Charles Trails STP, Heatherbrook Lagoon, Boschertown Lagoon, and Riverview Hills Septic Tank. Sewage pumping stations to be abandoned include: Riverview Drive, Bedford Mobile Park, Princess Jodi Mobile Park, Hutchins Metals, Heatherbrook No.1, and Heatherbrook No.2. Tables 2-8a-h also summarize the plans for the

Table 2-8a. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 1.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1990)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant or aerobic digester or land application or sludge lagoon	Duckett Creek
Harvester-Dardenne	Abandon (1985)	NA	NA	NA	NA
Hwy. 94 So.	Build (1985) Abandon (1988)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	Haul to Duckett Creek Plant	NA
Mississippi River	Expand (1985) Expand Phase II (1992)	Raw pumping, preliminary treatment, primary setting, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester or anaerobic digester or incinerator or land application or sludge lagoon	Mississippi River, Spencer Creek, Harvester-Dardenne and South Subareas
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Expand (1985) Abandon (1988)	Convert to contact stabilization, disinfection anaerobic digestion	Spencer Creek	Haul to Miss. River Plant or aerobic digester or land application or sludge lagoon	NA
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Brown Rd.	Expand (1985, 1992)				
Harvester-Dardenne	Expand (1985)				
Hwy. 94 So.	Build (1985)				
St. Peters	Effluent pump station (1985) Expand (1992)				
• SEWER LINES:					
H-D Plant - Dardenne Creek	Build (1985)	NA	NA	NA	NA
Hwy 94 South Plant - St. Peters/Cottleville Road	Build (1985)	NA	NA	NA	NA
St. Peters/Cottleville Rd - Mexico Road	Build (1985)	NA	NA	NA	NA
Brown Rd. - St. Peters Plant	Build (1985)	NA	NA	NA	NA
St. Peters Plant - Miss. River Plant	Build (1985)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA

• RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:

Monetary Considerations [1]		Environmental Considerations [2]			Other Considerations [2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
8	7	1	1	3	1	3	8

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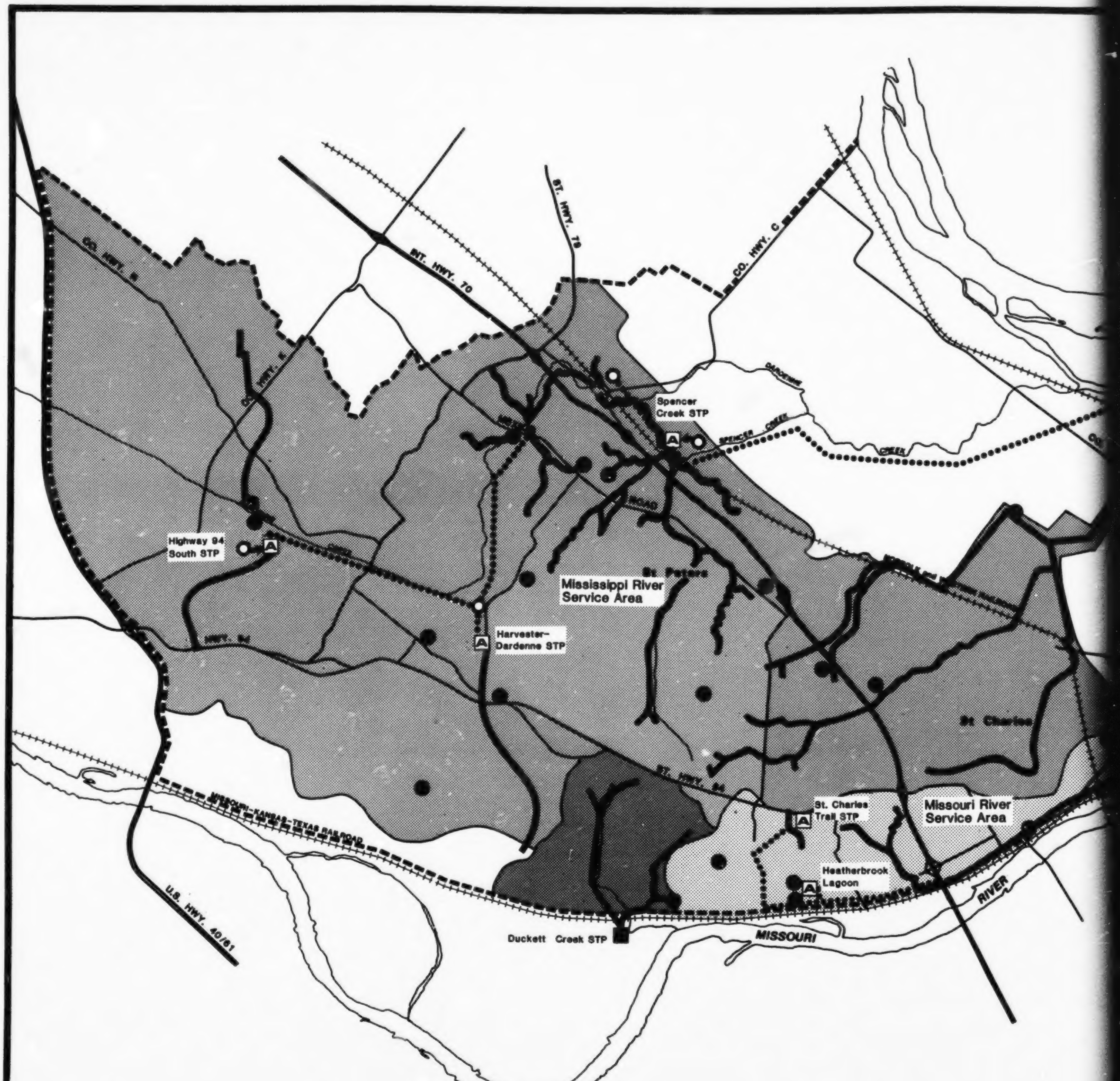
[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


CO. HWY. N
CO. HWY. K
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
DARDENNE
Spencer Creek STP
SPENCER CREEK
CREEK
ROAD
Highway 94 South STP
Mississippi River Service Area
St. Peters
Harvester-Dardenne STP
HWY. 94
St. Charles
ST. HWY. 94
St. Charles Trail STP
Missouri River Service Area
Heatherbrook Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
Duckett Creek STP
MISSOURI
RIVER

2-62,a

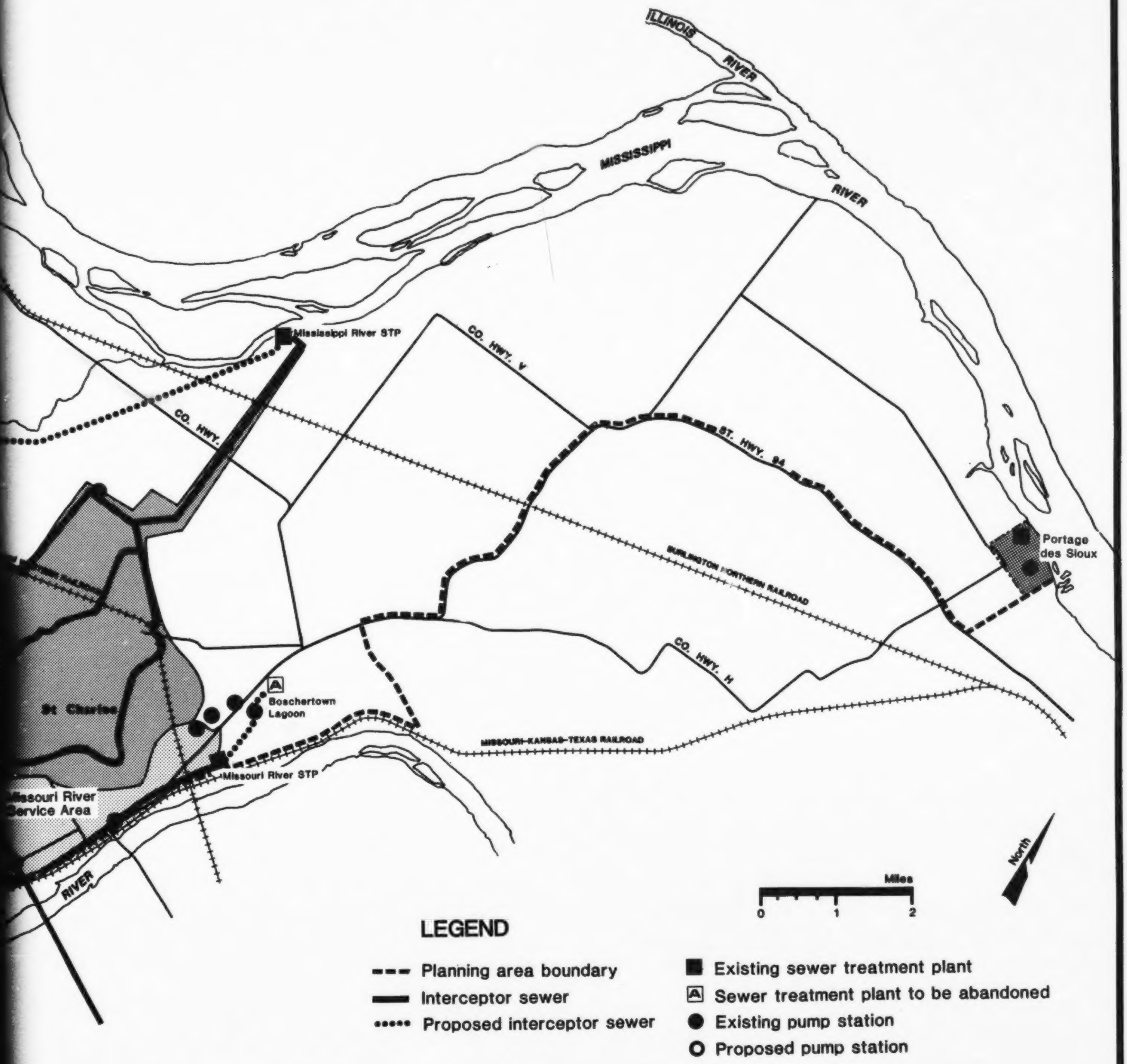

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
St. Charles
Boschertown Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
issouri River
ervice Area
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
Existing sewer treatment plant
A Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-4.
Alternative 1.

Table 2-8b. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 2.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1990)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant or aerobic digester or land application or sludge lagoon	Duckett Creek
Harvester-Dardenne	Build new plant (1985)	Contact stabilization, nitrification, disinfection, contact stabilization	Dardenne Creek	Haul to Mississippi River Plant or anaeorbic digester, land application or sludge lagoon	Harvester-Dardenne and South Subareas
Hwy. 94 So.	Build (1985) Abandon (1989)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	Haul to Duckett Creek Plant	NA
Mississippi River	Expand (1991)	Raw pumping, preliminary treatment, primary setting, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester or anaerobic digester or incinerator or land application or sludge lagoon	Mississippi River, and Spencer Subareas
Missouri River	Upgrade (1986)	Raw pumping, preliminary treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Abandon (1995)	NA	NA	NA	NA
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Harvester-Dardenne	Build (1988)				
Hwy. 94 So.	Build (1988)				
St. Peters	Effluent pump station (1993)				
• SEWER LINES:					
St. Peters Plant - Miss. River Plant	Build (1993)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA
South Plant to H-D Plant	Build (1986)	NA	NA	NA	NA

- RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:

Monetary Considerations[1]		Environmental Considerations[2]			Other Considerations[2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
6	8	3	6	5	7	3	7

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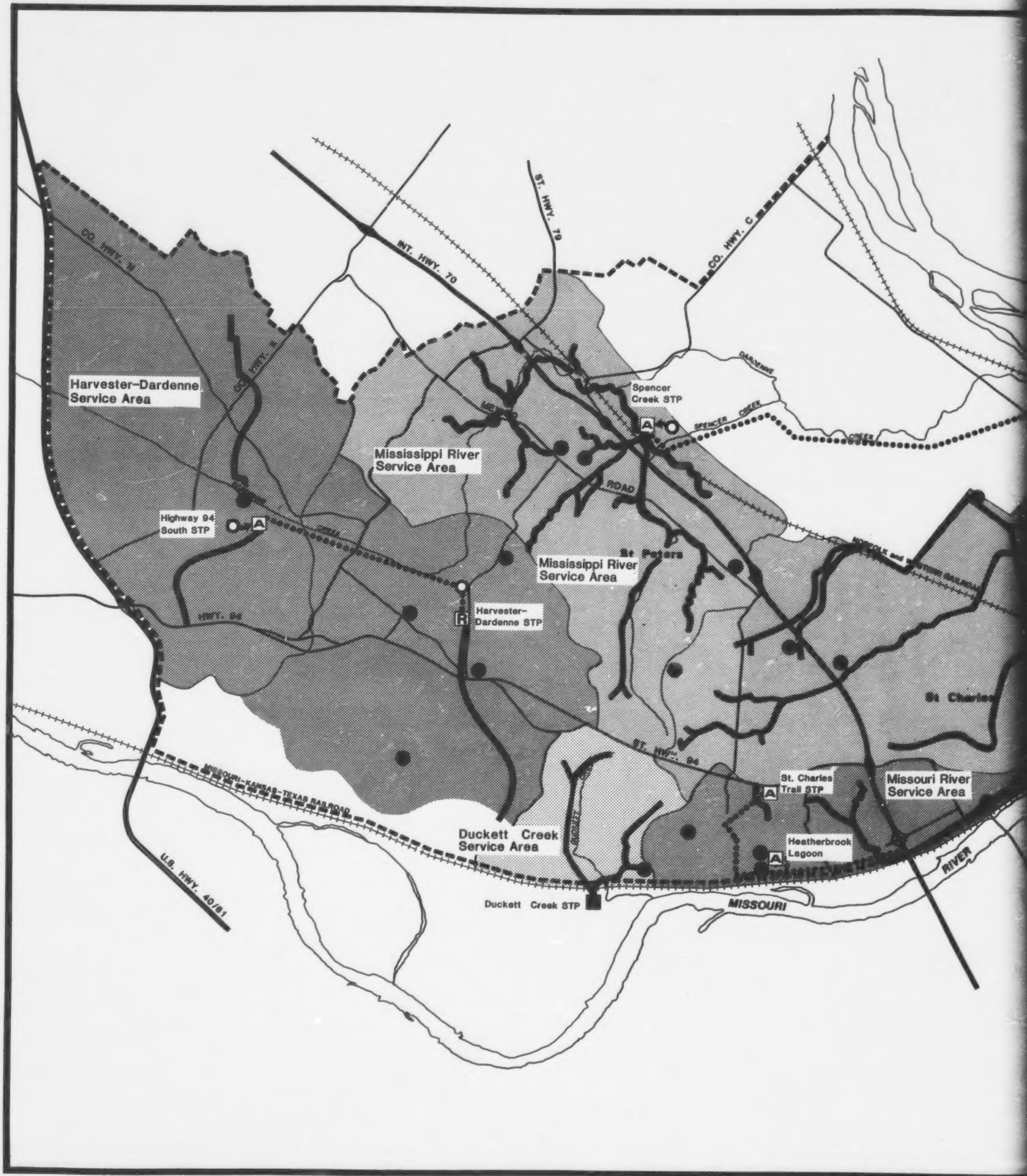
[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


Harvester-Dardenne Service Area
Mississippi River Service Area
Mississippi River Service Area
Duckett Creek Service Area
Missouri River Service Area
Spencer Creek STP
Highway 94 South STP
Harvester-Dardenne STP
St. Charles Trail STP
Heatherbrook Lagoon
Duckett Creek STP
St Peters
St Charles
A
A
A
A
R
CO. HWY. N
CO. HWY. N
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
DARDENNE
SPENCER CREEK
CREEK
ROAD
HWY. 94
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
MISSOURI RIVER

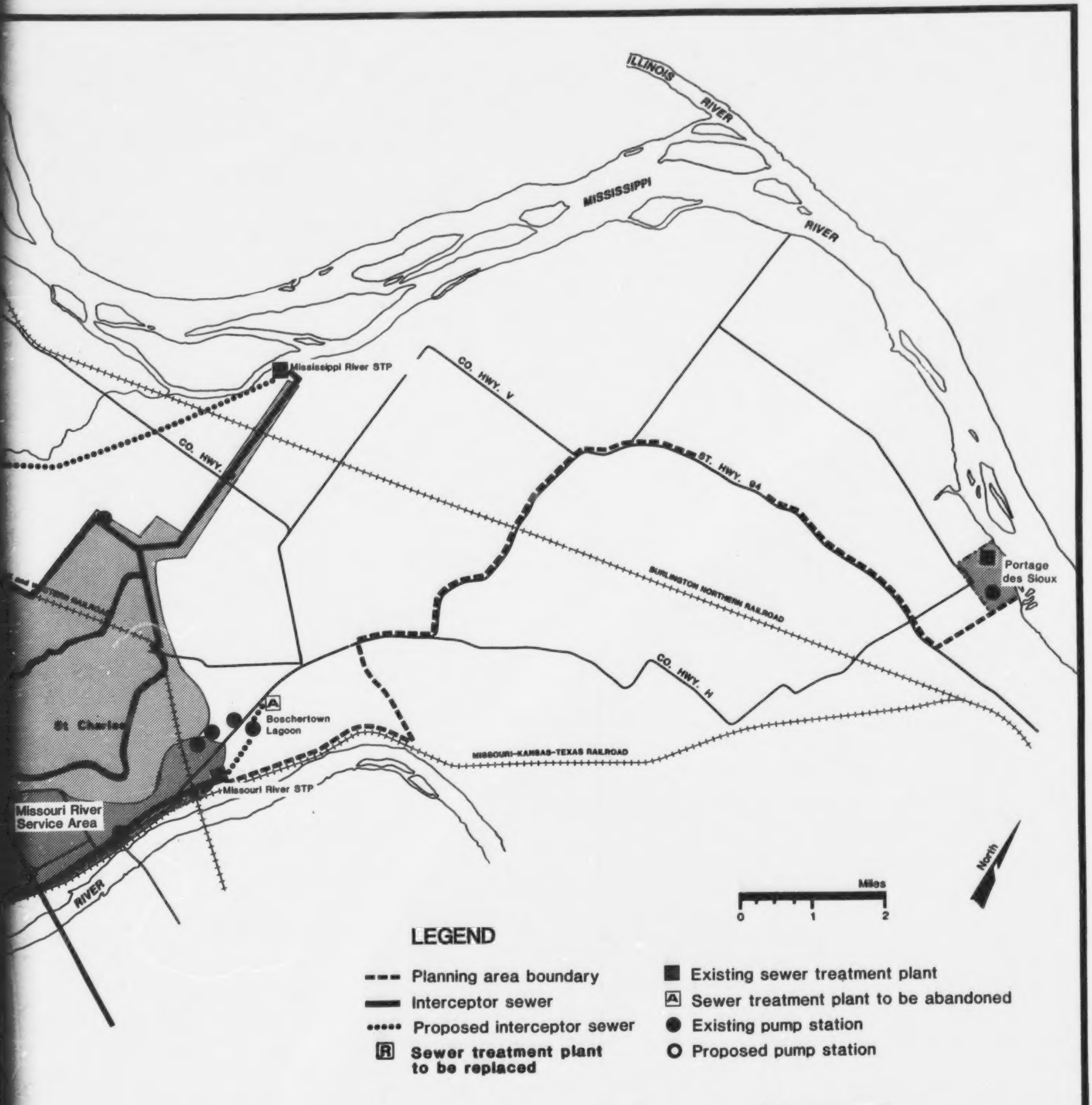

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
A
Boschertown Lagoon
St Charles
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
Missouri River Service Area
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
R Sewer treatment plant to be replaced
Existing sewer treatment plant
A Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-5.
Alternative 5.

Table 2-8c. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 3.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1990)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant or aerobic digester or land application or sludge lagoon	Duckett Creek
Harvester-Dardenne	Abandon (1985)	NA	NA	NA	NA
Hwy. 94 So.	Build (1985) Abandon (1989)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	NA	NA
Mississippi River	Expand (1993)	Raw pumping, preliminary treatment, primary setting, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester or anaerobic digester or incinerator or land application or sludge lagoon	Mississippi River Subarea
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Expand (1985)	Convert to contact stabilization, disinfection, anaerobic digestion	Spencer Creek (Mississippi River, 1985)	Haul to Miss. River Plant or aerobic digester or land application or sludge lagoon	Spencer Creek, South, and Harvester-Dardenne Subareas
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Brown Rd.	Expand (1985)				
Harvester-Dardenne	Expand (1985)				
Hwy. 94 So.	Build (1985)				
St. Peters	Effluent pump station (1985)				
• SEWER LINES:					
H-D Plant - Dardenne Creek	Build (1985)	NA	NA	NA	NA
Hwy 94 South Plant - St. Peters/Cottleville Road	Build (1988)	NA	NA	NA	NA
St. Peters/Cottleville Rd - Mexico Road	Build (1985)	NA	NA	NA	NA
Brown Rd. - St. Peters Plant	Build (1985)	NA	NA	NA	NA
St. Peters Plant - Miss. River	Build (1985)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA

- RANKING OF MONETARY AND NON-MONETARY CONSIDERATIONS:

Monetary Considerations[1]		Environmental Considerations[2]			Other Considerations[2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
7	4	1	1	3	4	3	5

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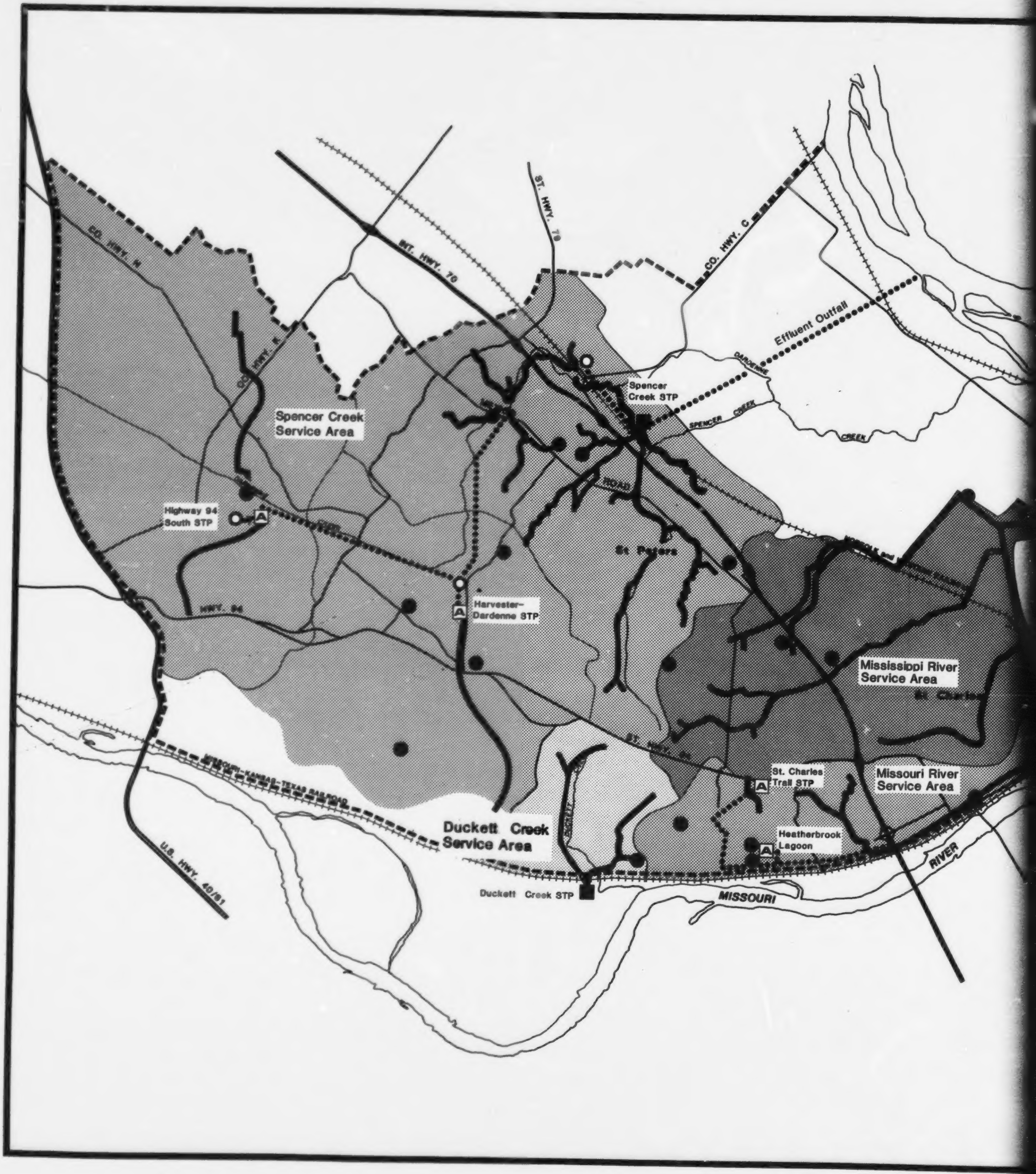
[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


CO. HWY. N
ST. HWY. 70
ST. HWY. 79
CO. HWY. C
CO. HWY. K
Spencer Creek Service Area
Effluent Outfall
DARDENNE
Spencer Creek STP
SPENCER CREEK
CREEK
ROAD
Highway 94 South STP
St. Peters
Harvester-Dardenne STP
HWY. 94
Mississippi River Service Area
St. Charles
ST. HWY. 94
St. Charles Trail STP
Missouri River Service Area
MISSOURI-KANSAS-TEXAS RAILROAD
Duckett Creek Service Area
Heatherbrook Lagoon
U.S. HWY. 40/61
Duckett Creek STP
MISSOURI
RIVER

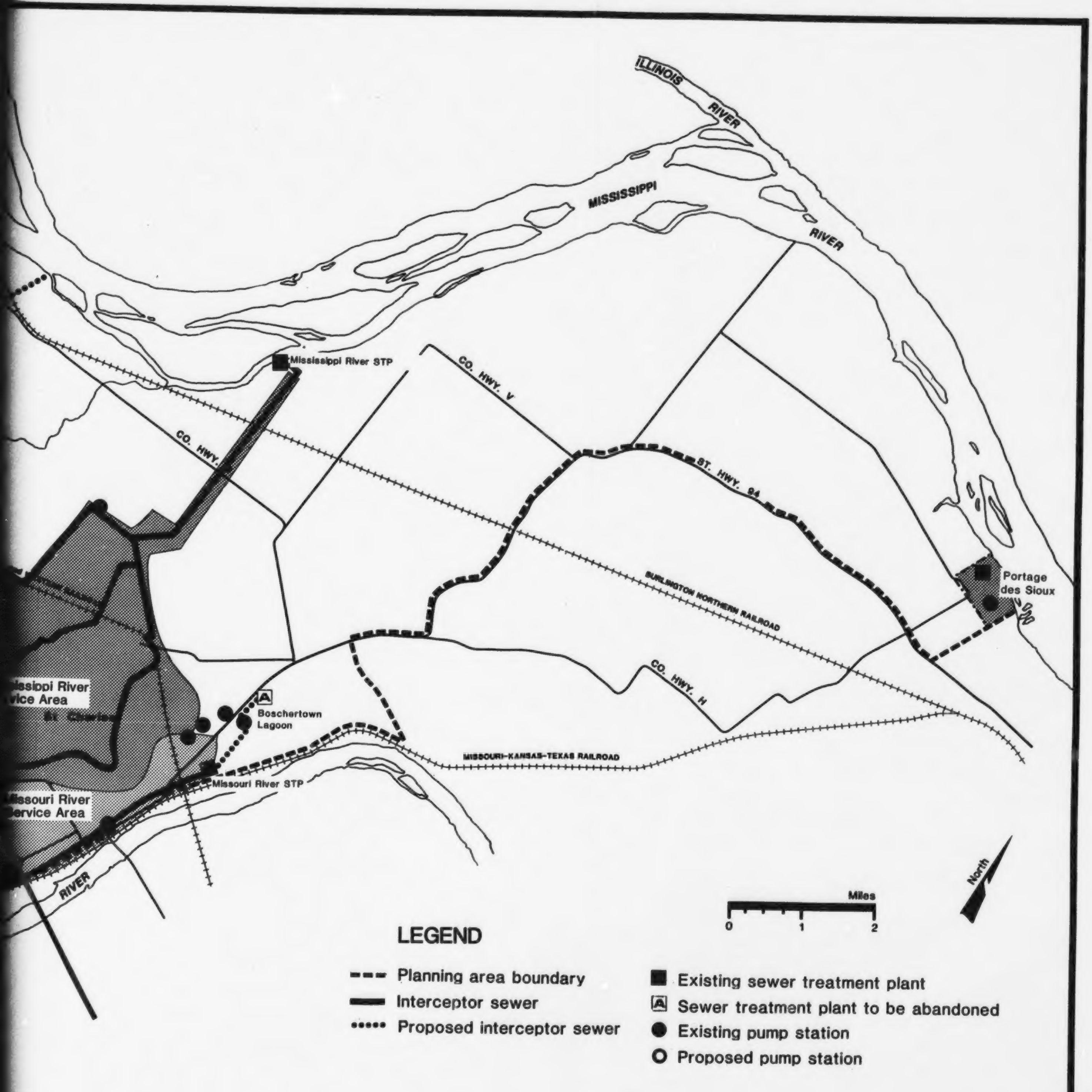

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
issippi River vice Area
St. Charles
Boschertown Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
issouri River ervice Area
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
Existing sewer treatment plant
Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-6.
Alternative 3.

Table 2-8d. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 4.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1990)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant or aerobic digester or land application or sludge lagoon	Duckett Creek
Harvester-Dardenne	Build new plant (1985)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	Haul to Miss. River Plant, or aerobic or anaerobic digestion, or land application or sludge lagoon	Harvester-Dardenne and South Subareas
Hwy. 94 So.	Build (1985) Abandon (1988)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	Haul to Duckett Creek Plant	NA
Mississippi River	Expand (1993)	Raw pumping, preliminary treatment, primary settling, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester, or anaerobic digester, or incinerator or land application or sludge lagoon	Mississippi River Subarea
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Expand (1998)	Convert to contact stabilization, disinfection, anaerobic digestion	Spencer Creek (Mississippi River, 1998)	Haul to Miss. River Plant or aerobic digester, or land application or sludge lagoon	Spencer Creek Subarea
• PUMP STATIONS:					
Boschertown	Build (1986)				
Harvester-Dardenne	Build (1988)	NA	NA	NA	NA
Hwy. 94 So.	Build (1988)				
St. Peters	Effluent pump station (1998)				
• SEWER LINES:					
St. Peters Plant - Miss. River	Build (1988)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA
South Plant to H-D Plant	Build (1988)	NA	NA	NA	NA

- RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:

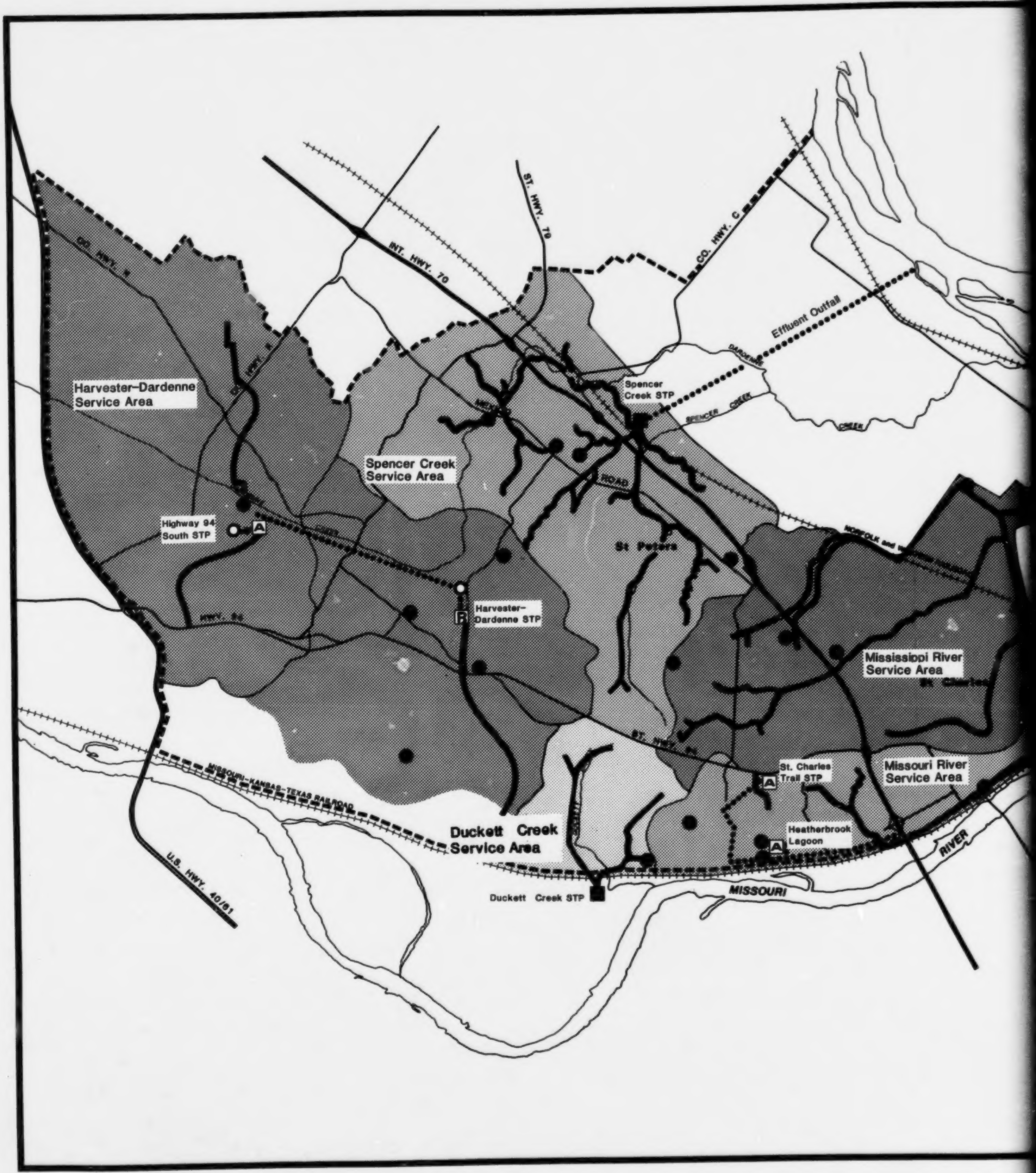
Monetary Considerations[1]		Environmental Considerations[2]			Other Considerations[2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
5	6	3	6	5	5	5	3

---

[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


CO. HWY. N
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
Effluent Outfall
DARDENNE
SPENCER CREEK
CREEK
Harvester–Dardenne Service Area
Spencer Creek Service Area
Spencer Creek STP
ROAD
St Peters
NORFOLK and
Highway 94 South STP
A
Harvester–Dardenne STP
R
HWY. 94
Mississippi River Service Area
St. Charles
ST. HWY. 94
St. Charles Trail STP
A
Missouri River Service Area
MISSOURI–KANSAS–TEXAS RAILROAD
Duckett Creek Service Area
Heatherbrook Lagoon
A
U.S. HWY. 40/61
Duckett Creek STP
MISSOURI
RIVER

2-68.a

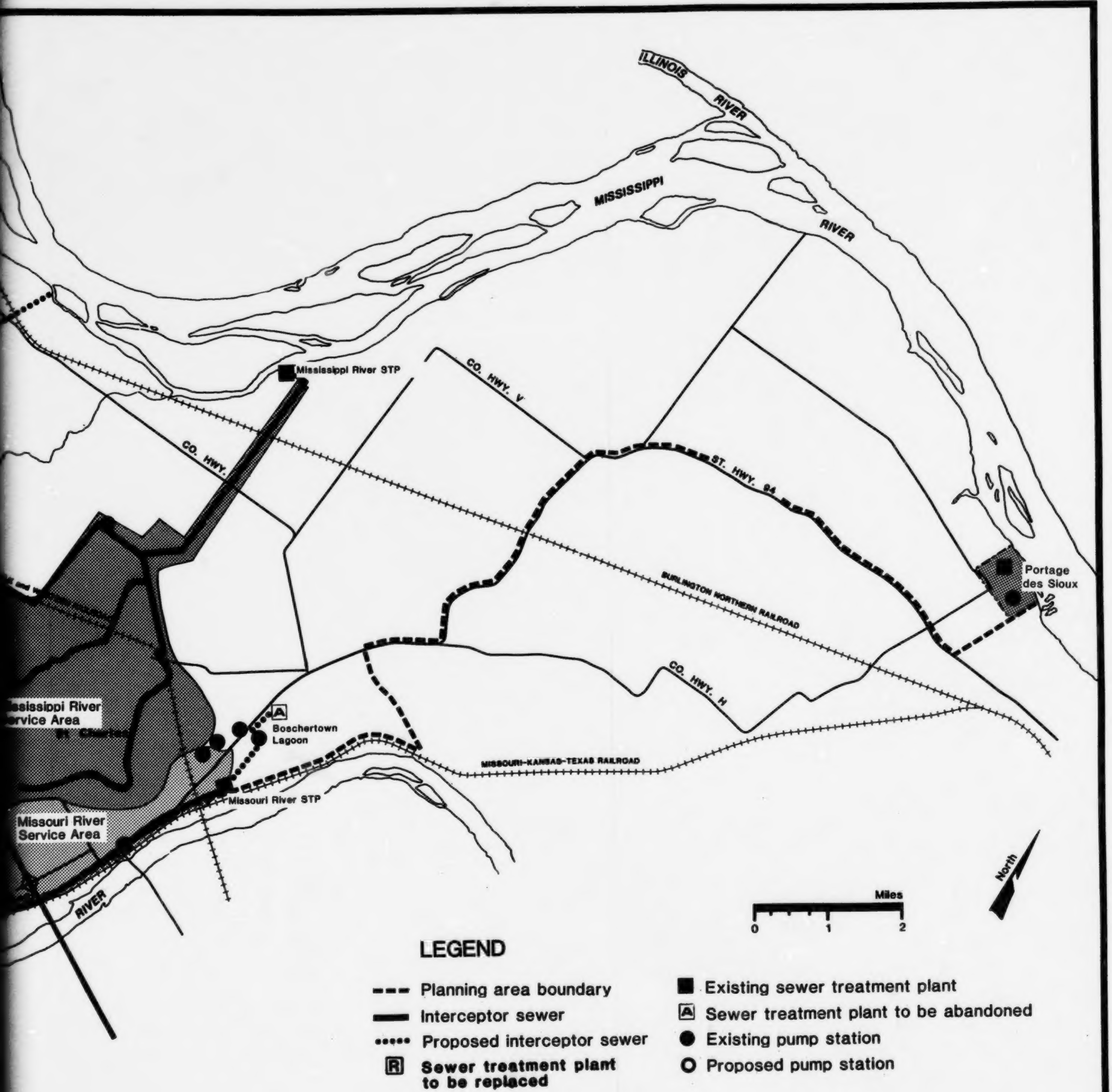

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
Mississippi River Service Area
St. Charles
Boschertown Lagoon
A
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
Missouri River Service Area
RIVER
Miles
0
1
2
North
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
R Sewer treatment plant to be replaced
Existing sewer treatment plant
A Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-7.
Alternative 4.

Table 2-8e. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 5.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1985)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant or aerobic digester or land application or sludge lagoon	Duckett Creek, Harvester-Dardenne and South Subareas
Harvester-Dardenne	Abandon (1985)	NA	NA	NA	NA
Hwy. 94 So.	Build (1985) Abandon (1989)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	NA	NA
Mississippi River	Expand (1992)	Raw pumping, preliminary treatment, primary settling, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester, or anaerobic digester, or incinerator or land application or sludge lagoon	Mississippi River, and Spencer Creek Subareas
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Abandon (1995)	NA	NA	NA	NA
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Dardenne Creek	Build (1988)				
Hwy. 94 So.	Build (1988)				
St. Peters	Effluent pump station (1993)				
Harvester-Dardenne	Expand (1985)				
• SEWER LINES:					
St. Peters Plant - Miss. River Plant	Build (1993)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA
South Plant to H-D Plant	Build (1988)	NA	NA	NA	NA

• RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:

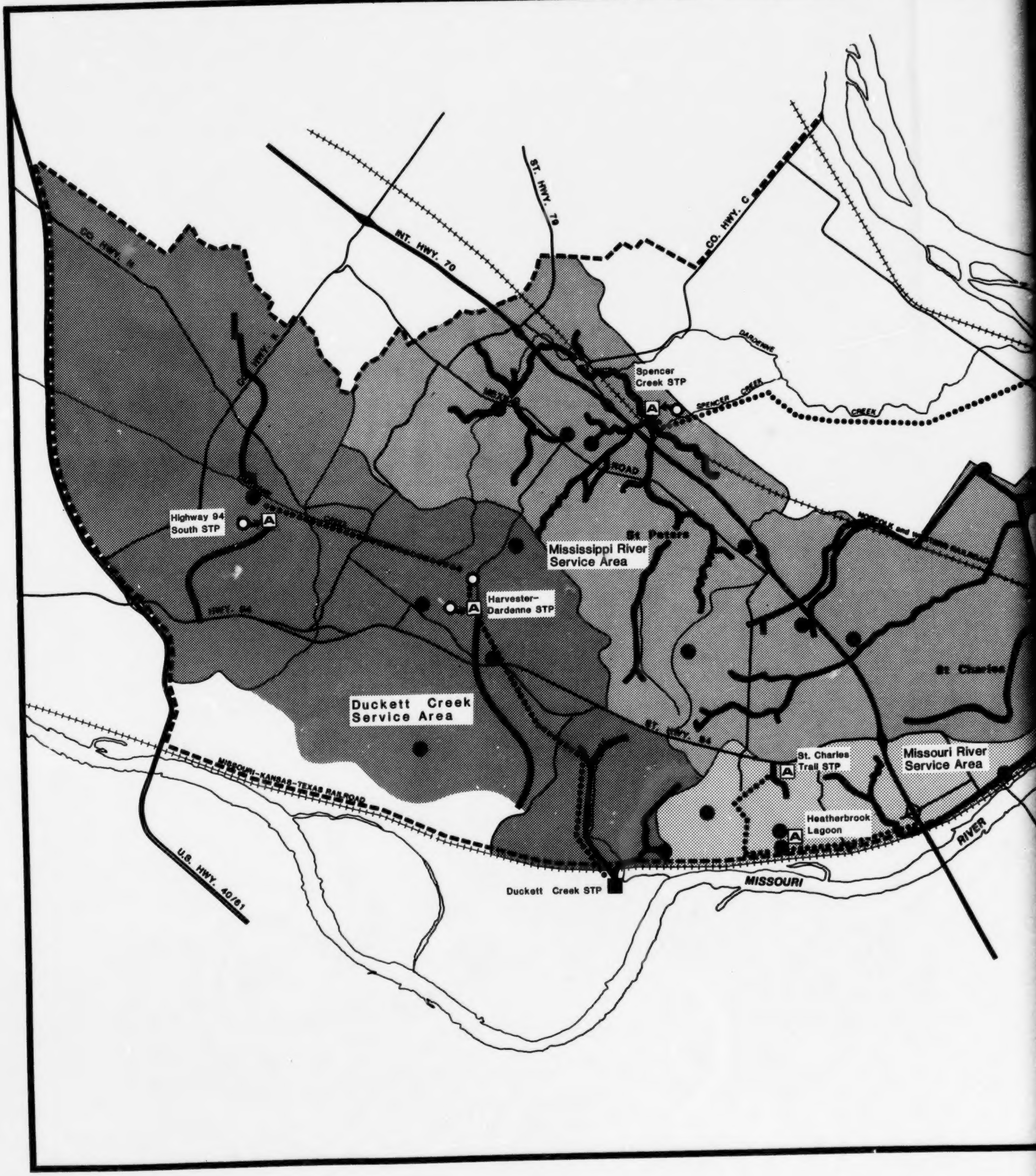
Monetary Considerations[1]		Environmental Considerations[2]			Other Considerations[2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
4	5	1	1	3	4	7	1

---

[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


INT. HWY. 70
ST. HWY. 79
CO. HWY. C
DARDENNE
SPENCER CREEK
CREEK
Spencer Creek STP
ROAD
St. Peters
Mississippi River Service Area
NORFOLK and WESTERN RAILROAD
Highway 94 South STP
HWY. 94
Harvester-Dardenne STP
Duckett Creek Service Area
ST. HWY. 94
St. Charles
St. Charles Trail STP
Missouri River Service Area
Heatherbrook Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Duckett Creek STP
MISSOURI
RIVER
U.S. HWY. 40/61

2-70.a

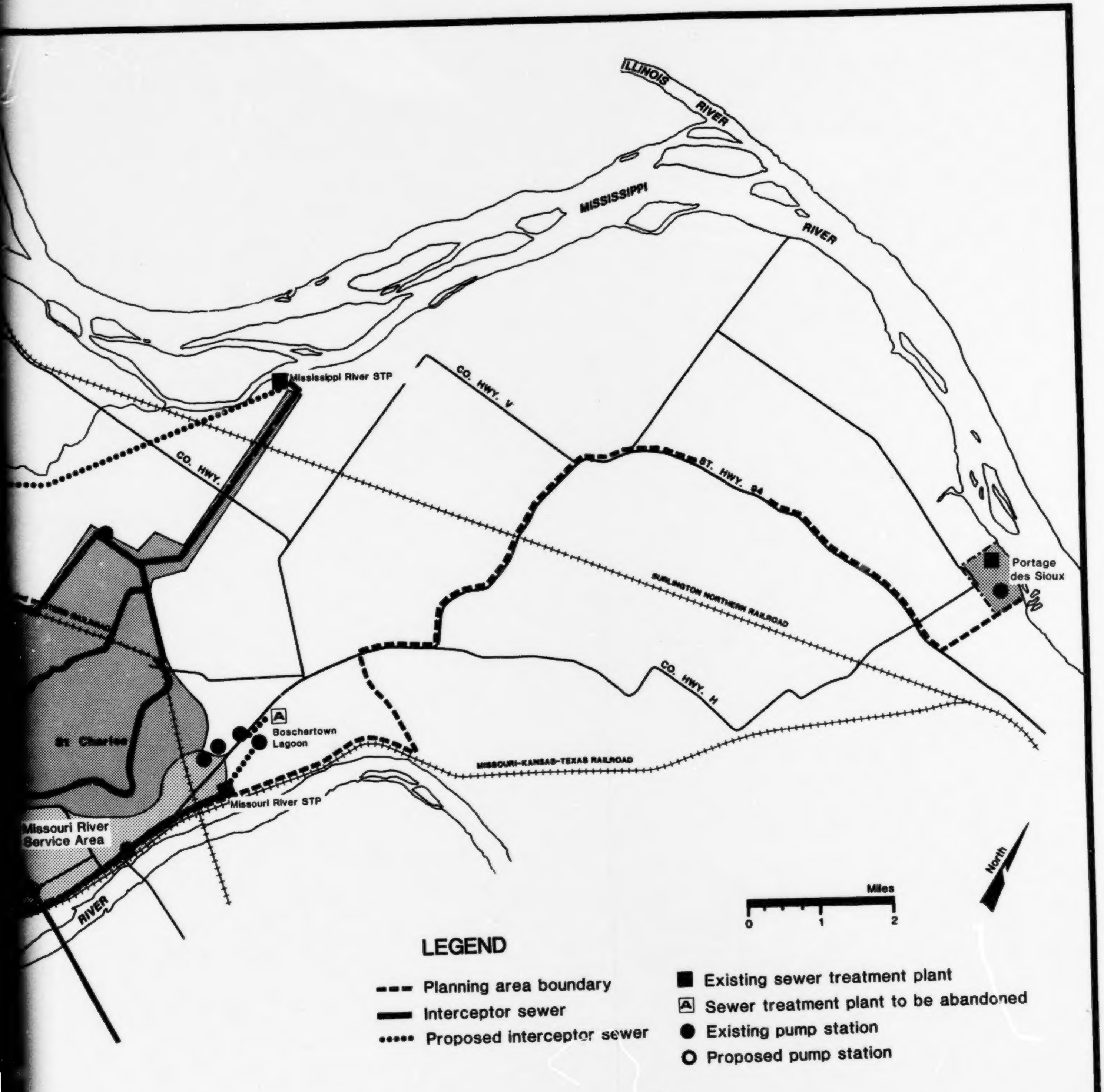

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
A
Boschertown Lagoon
St Charles
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
Missouri River Service Area
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
Existing sewer treatment plant
Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-8.
Alternative 5.

Table 2-8f. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 6.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1985)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant, or aerobic digester, or land application or sludge lagoon	Duckett Creek, South and Harvester-Dardenne Subareas
Harvester-Dardenne	Abandon (1985)	NA	NA	NA	NA
Hwy. 94 So.	Build (1985) Abandon (1989)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	NA	NA
Mississippi River	Expand (1993)	Raw pumping, preliminary treatment, primary settling, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester, or anaerobic digester, or incinerator, or land application or sludge lagoon	Mississippi River Subarea
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Expand (1998)	Convert to contact stabilization, disinfection, anaerobic digestion	Spencer Creek	Haul to Miss. River Plant, or aerobic digester, or land application or sludge lagoon	Spencer Creek Subarea
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Dardenne Creek	Build (1985)				
Hwy. 94 So.	Build (1988)				
St. Peters	Effluent pump station (1998)				
Harvester-Dardenne	Expand (1985)				
• SEWER LINES:					
St. Peters Plant - Miss. River Plant	Build (1998)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA
South Plant to H-D Plant	Build (1988)	NA	NA	NA	NA

- RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:

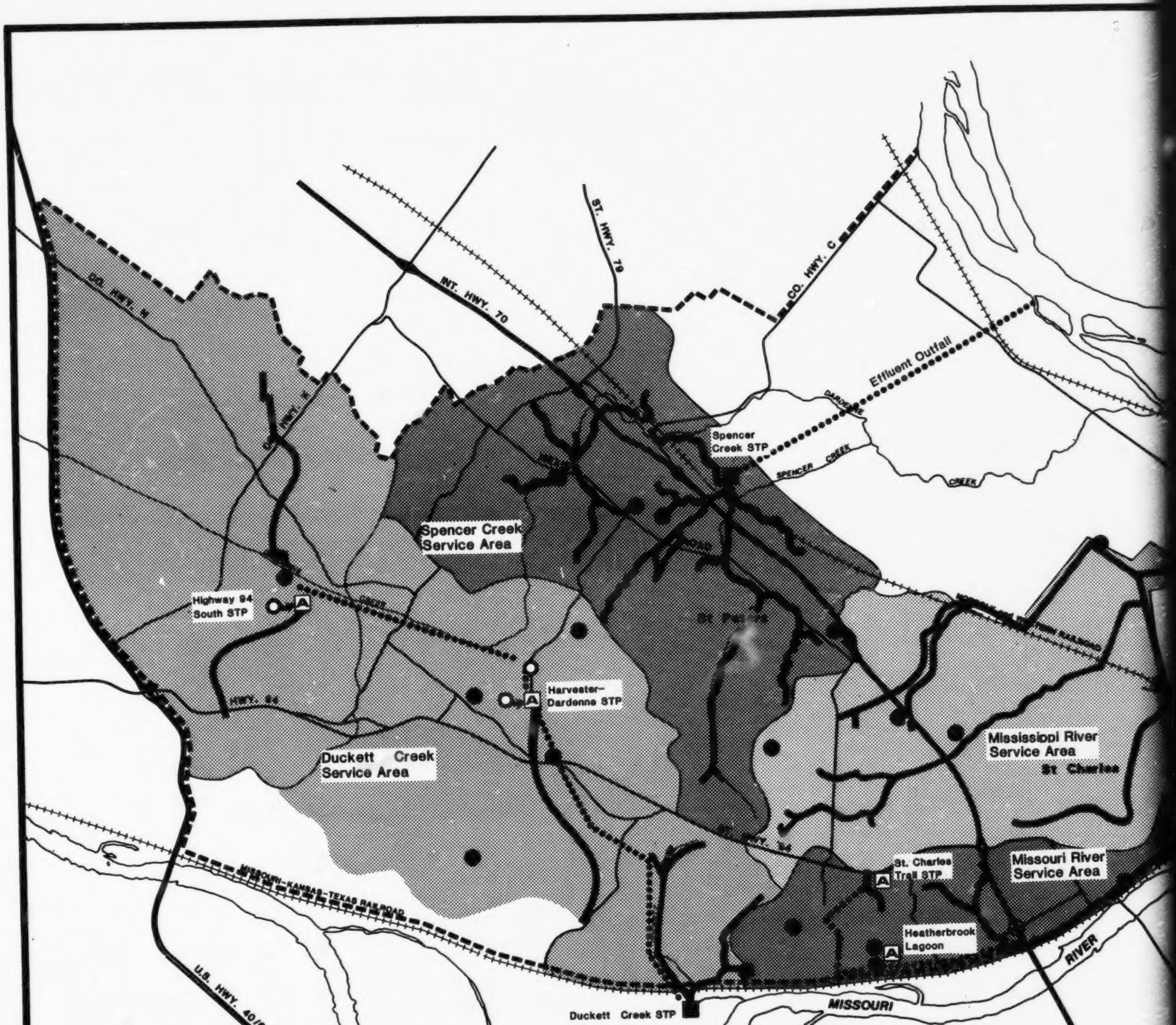
Monetary Considerations[1]		Environmental Considerations[2]			Other Considerations[2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
1	1	1	1	3	4	7	1

---

[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


CO. HWY. N
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
Effluent Outfall
DARDENNE
Spencer Creek STP
SPENCER CREEK
CREEK
Spencer Creek Service Area
Highway 94 South STP
Harvester-Dardenne STP
St Peters
HWY. 94
Duckett Creek Service Area
Mississippi River Service Area
St Charles
St. Charles Trail STP
Missouri River Service Area
Heatherbrook Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Duckett Creek STP
MISSOURI
RIVER
U.S. HWY. 40/61

2.72.a

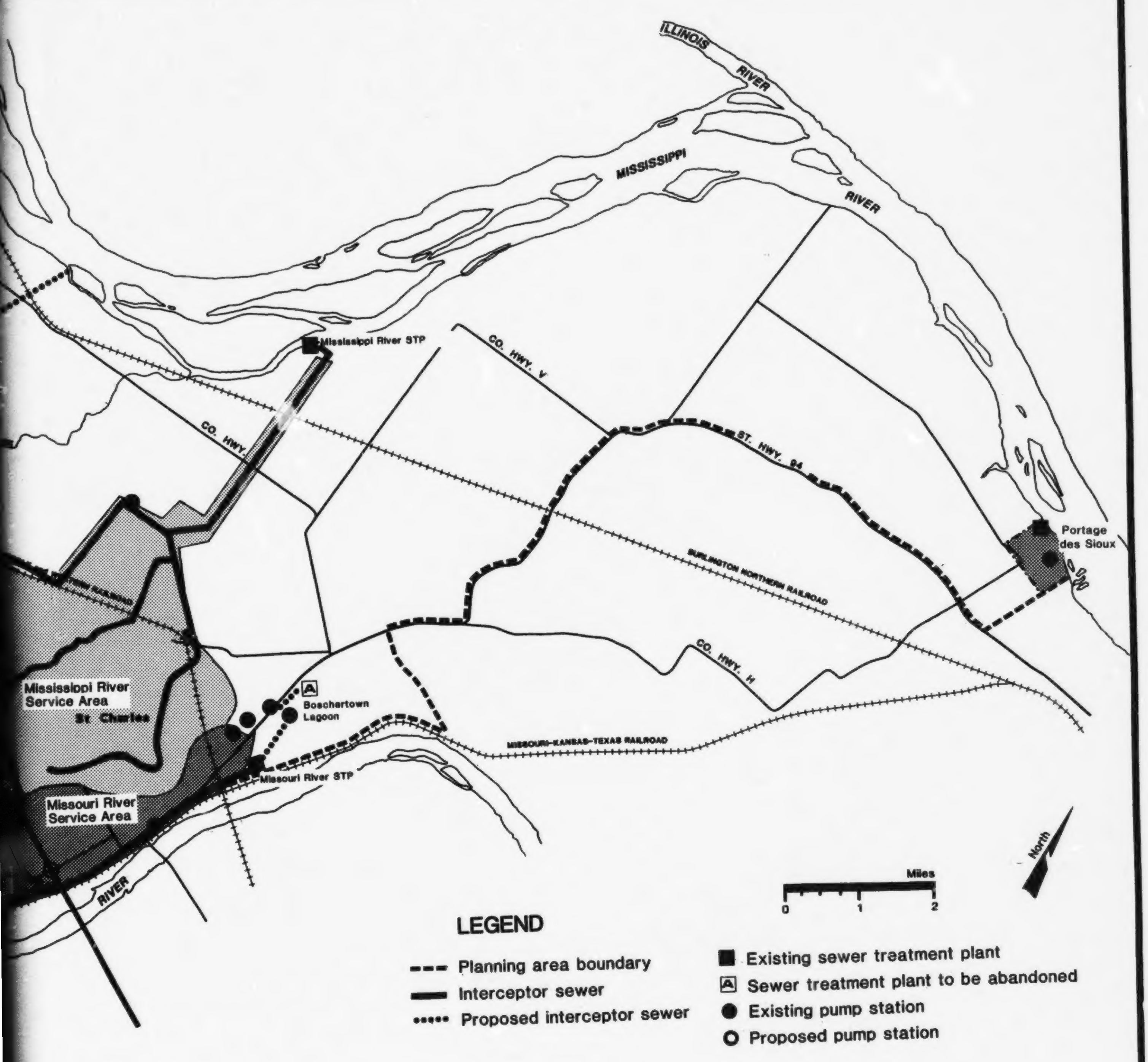

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
Mississippi River Service Area
St. Charles
Boschertown Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
Missouri River Service Area
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
Existing sewer treatment plant
Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-9.
Alternative 6.

Table 2-8g. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 7.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1985)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant, or aerobic digester, or land application or sludge lagoon	Duckett Creek and Harvester-Dardenne Subareas
Harvester-Dardenne	Abandon (1985)	NA	NA	NA	NA
Hwy. 94 So.	Build (1985) Abandon (1995)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	NA	NA
Mississippi River	Expand (1992)	Raw pumping, preliminary treatment, primary settling, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester, or anaerobic digester, or incinerator, or land application or sludge lagoon	Mississippi River, South, and Spencer Subareas
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Abandon (1995)	Convert to contact stabilization, disinfection, anaerobic digestion	Spencer Creek (until 1995)	Haul to Miss. River Plant, or aerobic digester, or land application or sludge lagoon	NA
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Brown Rd.	Expand (1992)				
Harvester-Dardenne	Expand (1985)				
Hwy. 94 So.	Build (1994)				
St. Peters	Build (1992)				
• SEWER LINES:					
Hwy 94 South Plant - St. St. Peters/ Cottleville Road	Build (1994)	NA	NA	NA	NA
St. Peters Cottleville Rd Mexico Road	Build (1994)	NA	NA	NA	NA
Brown Rd. St. Peters Plant	Build (1992)	NA	NA	NA	NA
St. Peters Plant Mississippi River Plant	Build (1992)	NA	NA	NA	NA
Boschertown Lagoon Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA

• RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:

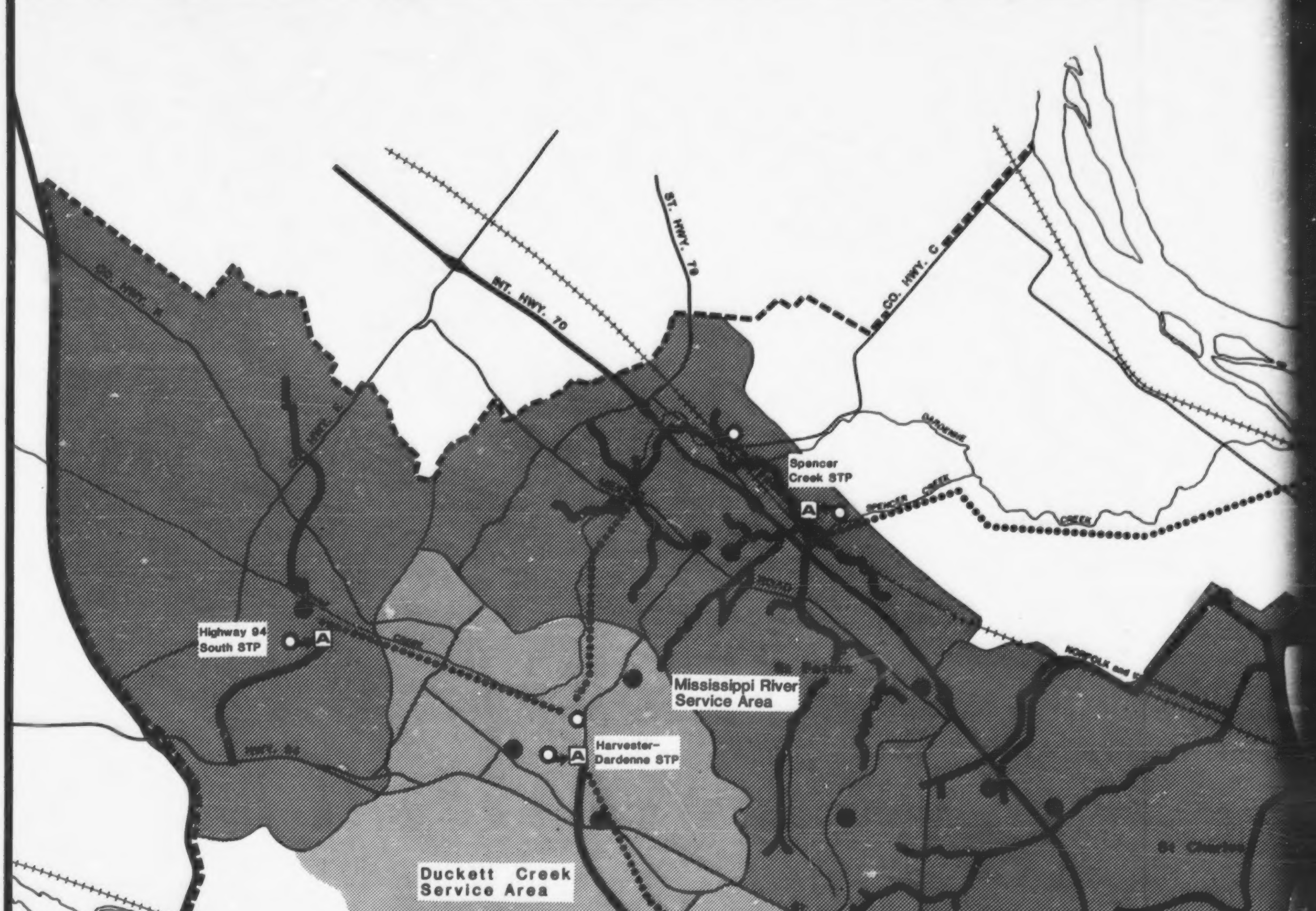
Monetary Considerations [1]		Environmental Considerations [2]			Other Considerations [2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
3	2	1	1	3	4	7	8

---

[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


ST. HWY. 79
INT. HWY. 70
CO. HWY. C
CO. HWY. N
Spencer Creek STP
SPENCER CREEK
DARDENNE CREEK
ROAD
St. Peters
NORFOLK and
Highway 94 South STP
Mississippi River Service Area
Harvester-Dardenne STP
HWY. 94
St. Charles
Duckett Creek Service Area
ST. HWY. 94
MISSOURI–KANSAS–TEXAS RAILROAD
St. Charles Trail STP
Missouri River Service Area
Heatherbrook Lagoon
Duckett Creek STP
MISSOURI RIVER
U.S. HWY. 40/61
A

2-74.a

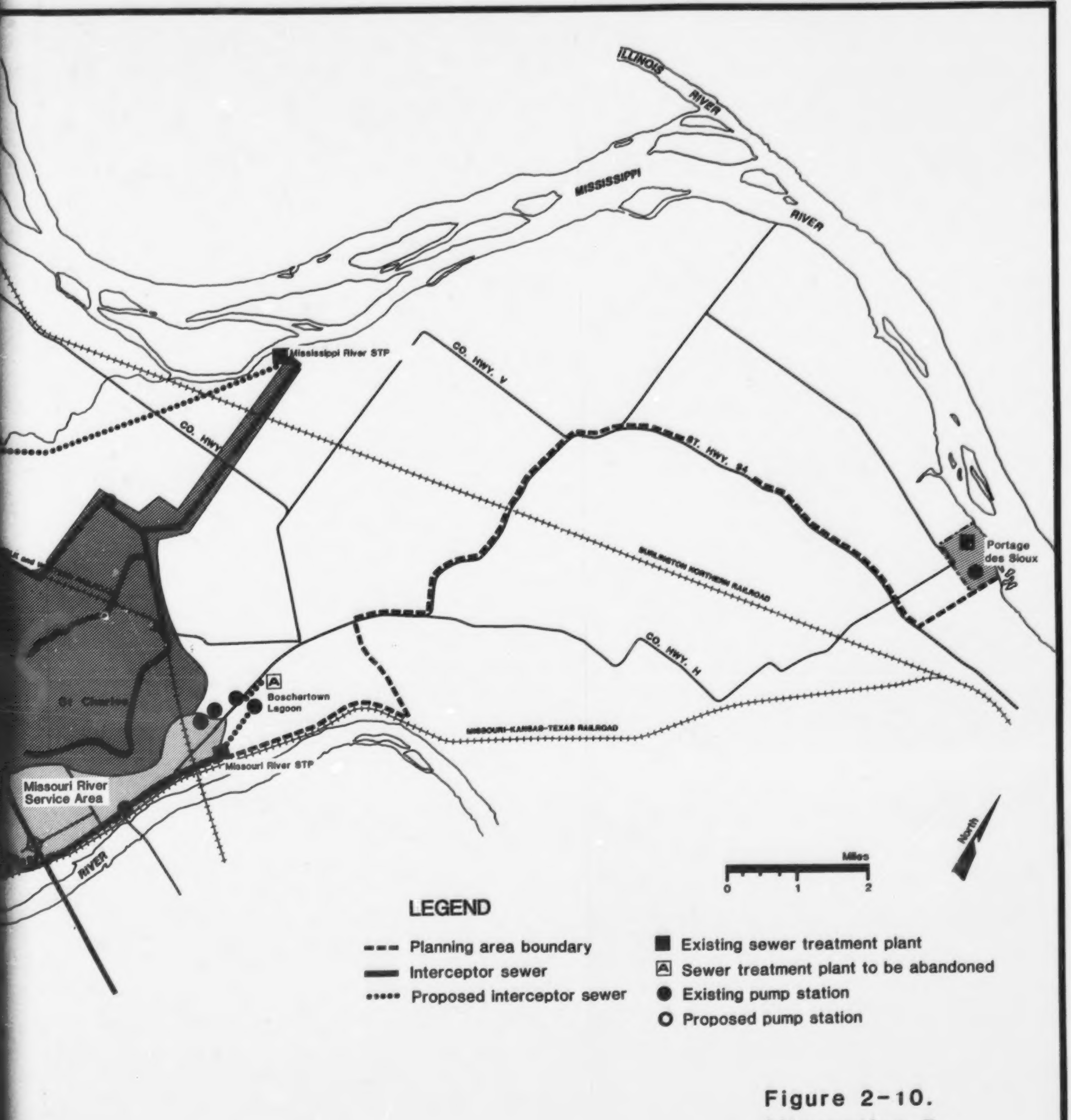

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
St. Charles
Boschertown Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
Missouri River Service Area
RIVER
North
Miles
0
1
2
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
Existing sewer treatment plant
Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-10.
Alternative 7.

Table 2-8h. Summary of Preliminary Alternatives Evaluated in Draft Facilities Plan, Alternative 8.

Wastewater Treatment Facility - Construction and Treatment Plans

Facility	Const./Modification (year)	Treatment Process(es)	Effluent Disposal	Sludge Treatment/Disposal	Final Service Area
• PLANTS:					
Duckett Creek	Build new plant (1985)	Raw pumping, oxidation ditch, aerobic digestion	Duckett Creek	Haul to Mississippi River Plant, or aerobic digester, or land application or sludge lagoon	Duckett Creek and Harvester-Dardenne Subareas
Harvester-Dardenne	Abandon (1985)	NA	NA	NA	NA
Hwy. 94 So.	Build (1985) Abandon (1995)	Contact stabilization, nitrification, disinfection, aerobic digestion	Dardenne Creek	NA	NA
Mississippi River	Expand (1993)	Raw pumping, preliminary treatment, primary settling, step aeration, disinfection, sludge thickening, aerobic digestion, effluent pumping	Mississippi River	Gravity thickener, aerobic digester, or anaerobic digester, or incinerator, or land application or sludge lagoon	Mississippi River Subarea
Missouri River	Upgrade (1986)	Raw pumping, prelim. treatment, contact stabilization, sludge thickening	Missouri River	Gravity thickener, haul to Miss. River plants, aerobic digester, or land application	Missouri River Subarea
St. Peters	Expand (1992)	Convert to contact stabilization, disinfection, anaerobic digestion	Spencer Creek (Mississippi River, 1992)	Haul to Miss. River Plant, or aerobic digester, or land application or sludge lagoon	Spencer Creek and South Subareas
• PUMP STATIONS:					
Boschertown	Build (1986)	NA	NA	NA	NA
Brown Rd.	Expand (1992)				
Harvester-Dardenne	Expand (1985)				
Hwy. 94 So.	Build (1994)				
St. Peters	Effluent pump station (1992)				
• SEWER LINES:					
Hwy 94 South Plant - St. Peters/Cottleville Road	Build (1994)	NA	NA	NA	NA
St. Peters/Cottleville Rd - Mexico Road	Build (1994)	NA	NA	NA	NA
Brown Rd. - St. Peters Plant	Build (1992)	NA	NA	NA	NA
St. Peters Plant - Miss. River	Build (1992)	NA	NA	NA	NA
Boschertown Lagoon - Missouri River Plant	Build (1986)	NA	NA	NA	NA
St. Charles Trails Plant to I-70	Build (1986)	NA	NA	NA	NA

- **RANKINGS OF MONETARY AND NON-MONETARY CONSIDERATIONS:**

Monetary Considerations[1]		Environmental Considerations[2]			Other Considerations[2]		
Total Present Worth Ranking	User Fee Ranking	Water Quality Ranking	Aesthetics, Noise and Odor Ranking	Recreational Ranking	Reliability Ranking	Flexibility Ranking	Implementability Ranking
2	3	1	1	3	4	7	5

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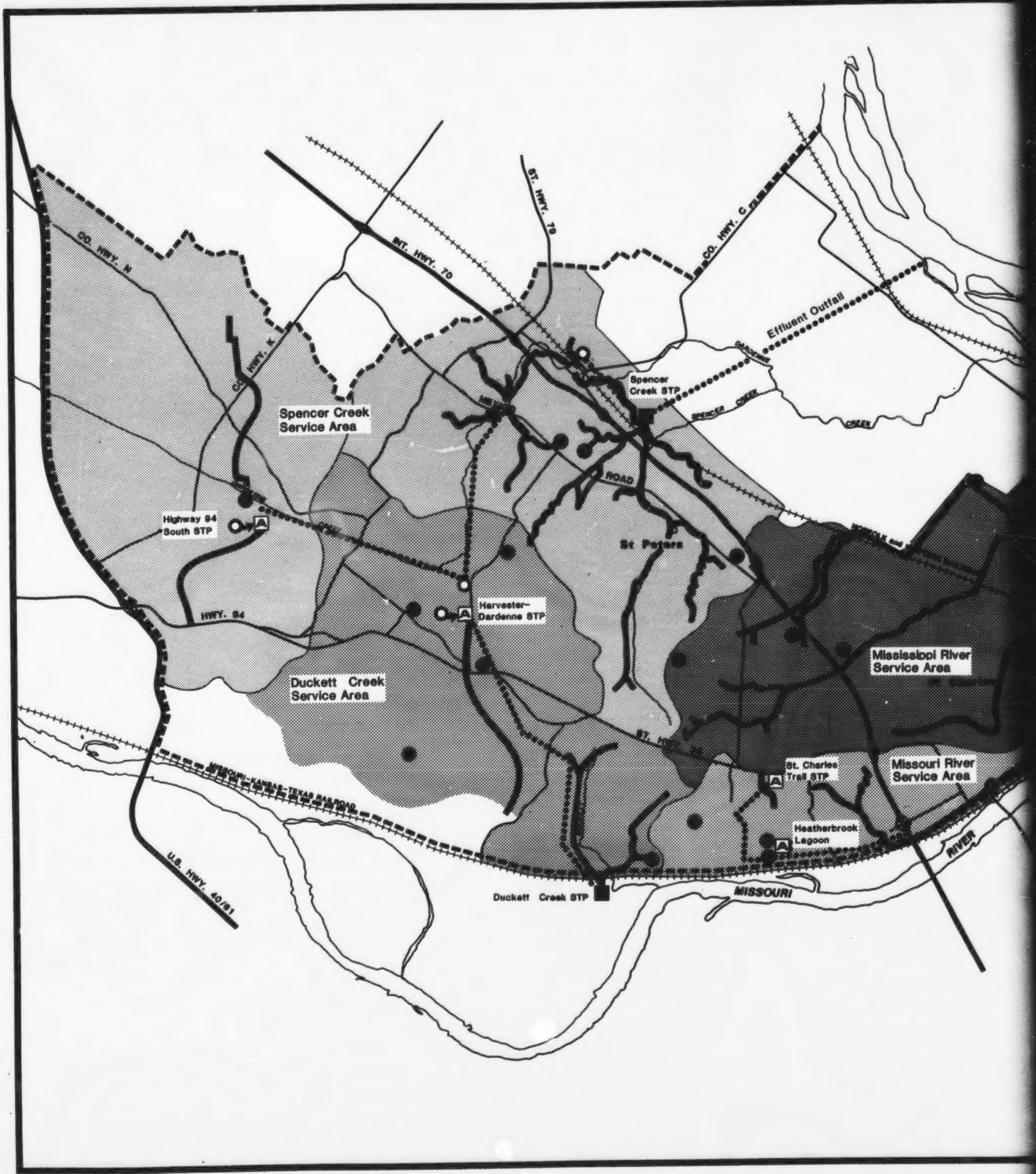
[1] Rankings in actual relation to other alternatives

[2] Rankings are not in relation to other alternatives - Low numbers indicate favorable characteristics

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)


CO. HWY. N
ST. HWY. 70
ST. HWY. 79
CO. HWY. C
Effluent Outfall
CO. HWY. K
Spencer Creek Service Area
Spencer Creek STP
SPENCER CREEK
CREEK
DARDENNE
ROAD
Highway 94 South STP
St Peters
Harvester-Dardenne STP
HWY. 94
Mississippi River Service Area
Duckett Creek Service Area
ST. HWY. 94
St. Charles Trail STP
Missouri River Service Area
Heatherbrook Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
Duckett Creek STP
MISSOURI
RIVER

2-76.a

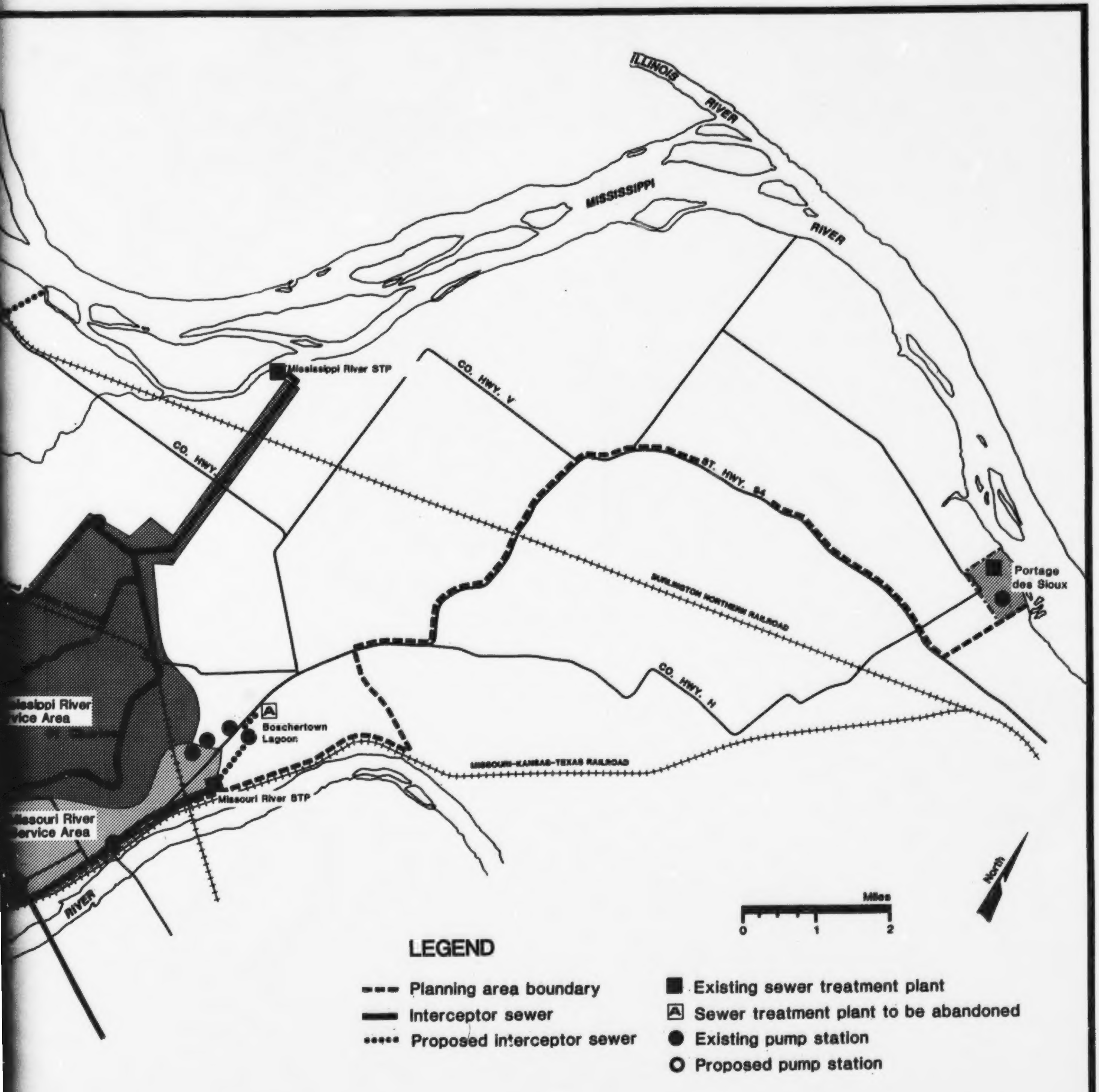

ILLINOIS RIVER
MISSISSIPPI RIVER
Mississippi River STP
CO. HWY. V
CO. HWY.
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage des Sioux
CO. HWY. H
Boschertown Lagoon
MISSOURI-KANSAS-TEXAS RAILROAD
Missouri River STP
ssissippi River
vice Area
issouri River
ervice Area
RIVER
Miles
0
1
2
North
LEGEND
Planning area boundary
Interceptor sewer
Proposed interceptor sewer
Existing sewer treatment plant
Sewer treatment plant to be abandoned
Existing pump station
Proposed pump station

Figure 2-11.
Alternative 8.

individual STPs, pump stations, and interceptor lines for each alternative as well as the proposed effluent and sludge treatment and disposal methods and results of the monetary, non-monetary, and environmental rankings of each of the eight preliminary alternatives.

The Highway 94-South STP would serve as an interim facility under each alternative. As an interim facility, the existing facilities would be expanded and upgraded. These facilities would provide service for projected growth in the south subarea and would be abandoned after 1988, when an interceptor sewer would be constructed and would convey wastewater to another treatment facility. The Mississippi River STP would be expanded from a 5.5 mgd to a 7.0, 10.5, 12.0, or 14.5 mgd facility, depending on the alternative selected. Under Alternative 1, the Mississippi River STP would become a major regional treatment plant requiring expansion to 14.5 mgd, while the Spencer Creek STP, Highway 94-South STP, and Harvester-Dardenne STP would be abandoned.

The Spencer Creek STP would either be abandoned or expanded, depending on the alternative selected. Under Alternative 1, it would serve as an interim facility, and would be expanded to a 4.0 mgd treatment plant which would be abandoned in 1988. Under Alternatives 3, 4, 6, and 8, the plant would be expanded and an outfall would convey secondary effluent to the Mississippi River. By constructing the outfall to the Mississippi River, the need to upgrade the STP to provide ammonia removal capabilities is eliminated.

The Harvester-Dardenne STP would be abandoned under Alternatives 1, 3, 5, 6, 7, and 8. Under Alternatives 2 and 4, the existing facility would be replaced by a new 4.0 mgd treatment plant with nitrification capabilities. The existing Duckett Creek STP would be replaced by a new secondary treatment plant under all the alternatives. The design flow rate would vary from 1.0 mgd to 5.0 mgd, depending on the alternative selected.

The Missouri River STP would be expanded and upgraded to a 5.0 mgd secondary treatment facility under all the alternatives. There is no difference between any of the alternatives with respect to the Missouri River STP.

In addition to the eight interceptor sewer system alternatives that would convey wastewater from the six sewer service areas, the facilities planners considered the possibility of conveying wastewater from communities located in the Mississippi River floodplain to either the Portage des Sioux STP or the Mississippi River STP. As illustrated in Figure 2-12, wastewater from the communities of Peruque, Kampville, South Shore, Prairie Homes, and Woodland Harbor, in addition to the St. Louis Yacht Club, would be conveyed to the Mississippi River STP. The Portage des Sioux STP would receive wastewater from Alton Lake Estates, as illustrated in Figure 2-13.

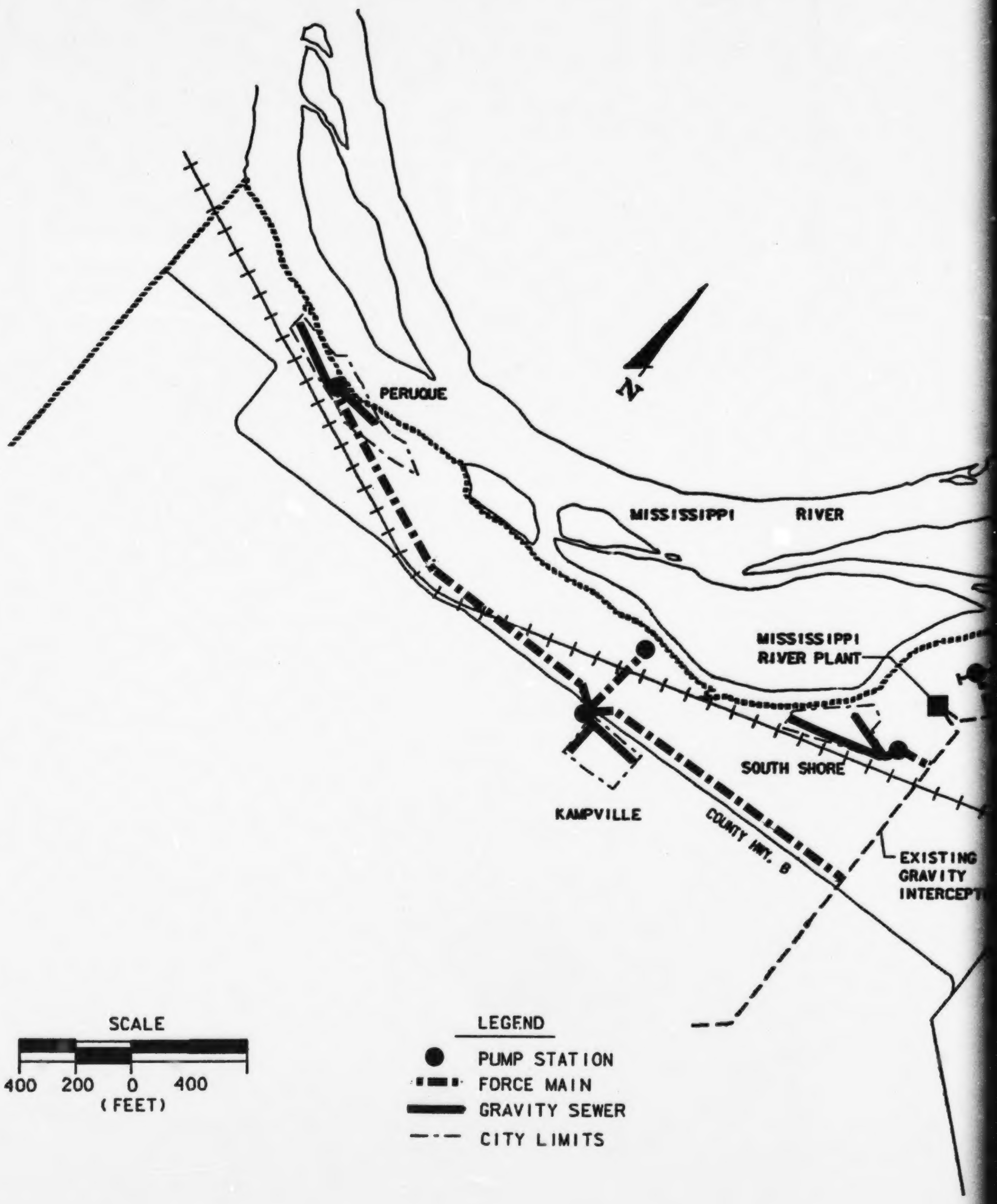
Within the Missouri River watershed, the facilities planners evaluated the cost-effective service area and capacity of both the existing Duckett Creek STP and the Missouri River STP. The possibility of eliminating the Missouri River STP and conveying wastewater from the Missouri River subarea to the Mississippi River STP for treatment was also analyzed.

2.3.1.2 Wastewater Treatment and Disposal Options

For each municipal STP to be utilized under the eight alternatives described in the previous section, various treatment and disposal options were considered by the facilities planner. These options were subdivided into a set of options for liquid (wastewater) and a set of options for sludge. The list of options considered for each STP is presented in Table 2-9.

2.3.1.3 Screening the Preliminary Alternatives

A variety of factors including costs, environmental constraints, reliability, flexibility, and implementability were considered in the facilities plan for selecting systems for detail evaluation. Three environmental factors, water quality, aesthetics, and recreational potential were also considered. Water quality concerns centered primarily around Dardenne Creek which runs through residential neighborhoods. The alternatives that would avoid discharge to Dardenne Creek were favored in the screening process. Aesthetic concerns refer to the obtrusiveness or remoteness of the treatment plants. Recreational concerns center around children playing in Dardenne Creek.


N
PERUQUE
MISSISSIPPI RIVER
MISSISSIPPI
RIVER PLANT
KAMPVILLE
SOUTH SHORE
COUNTY HWY. B
EXISTING
GRAVITY
INTERCEPT
SCALE
400 200 0 400
(FEET)
LEGEND
● PUMP STATION
FORCE MAIN
GRAVITY SEWER
CITY LIMITS

2-79.a

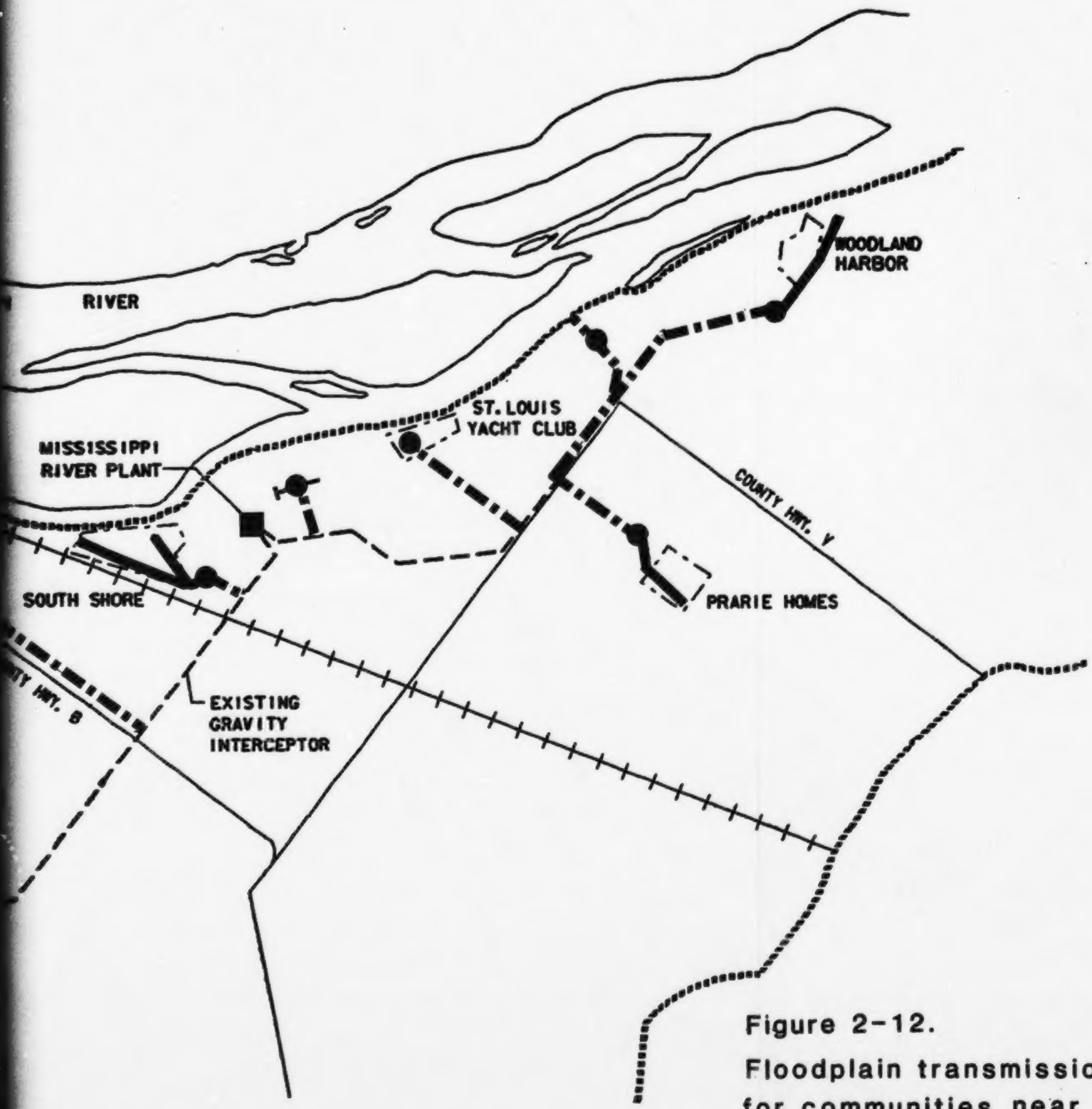

RIVER
WOODLAND HARBOR
ST. LOUIS YACHT CLUB
MISSISSIPPI RIVER PLANT
COUNTY HWY. Y
SOUTH SHORE
PRARIE HOMES
EXISTING GRAVITY INTERCEPTOR
TY HWY. B

Figure 2-12.
Floodplain transmission system for communities near the Mississippi River STP.

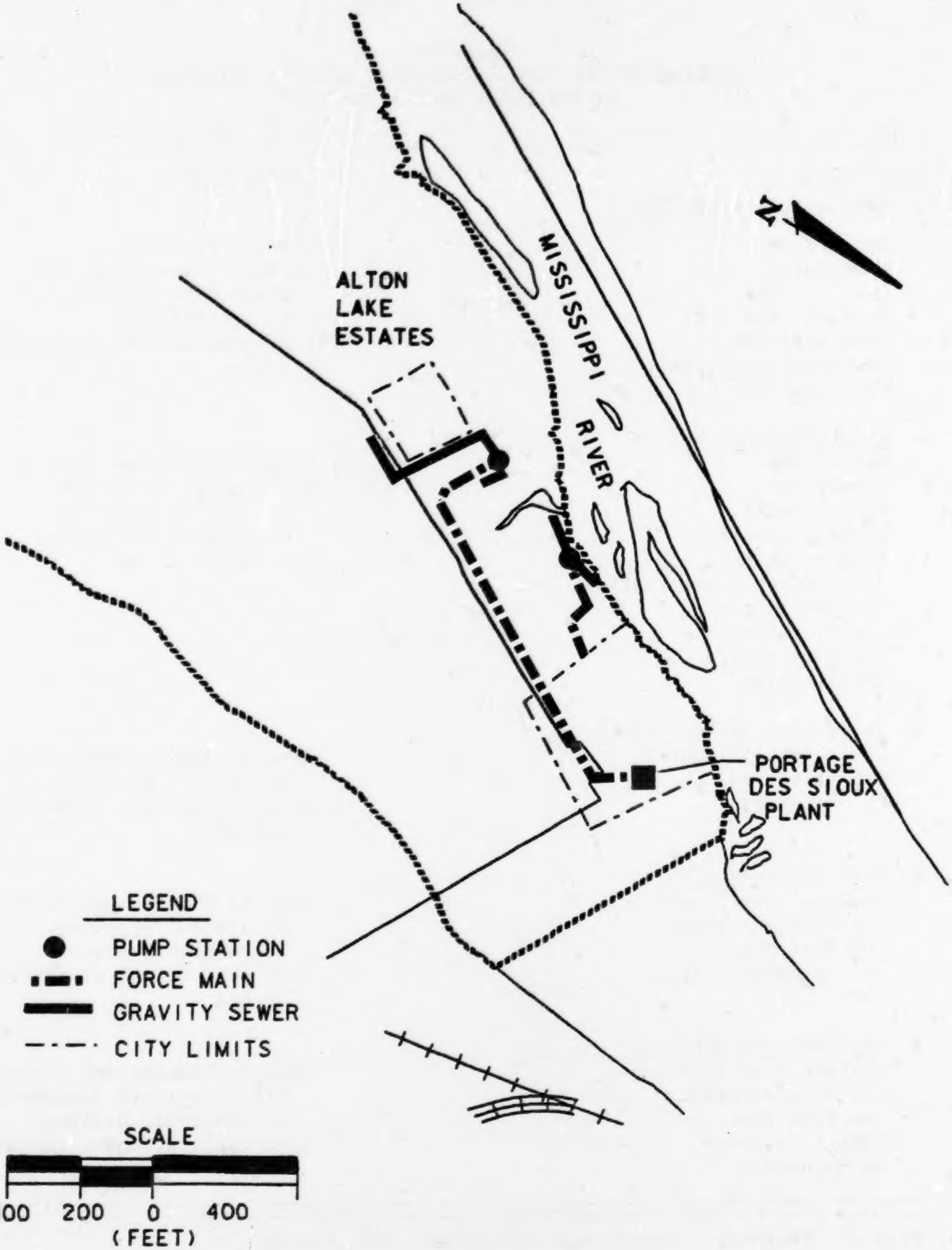

N
MISSISSIPPI RIVER
ALTON LAKE ESTATES
PORTAGE DES SIOUX PLANT
LEGEND
● PUMP STATION
FORCE MAIN
GRAVITY SEWER
CITY LIMITS
SCALE
400 200 0 400
(FEET)

Figure 2-13. Floodplain transmission system for communities near the Missouri River STP.

TABLE 2-9

WASTEWATER AND SLUDGE TREATMENT OPTIONS EVALUATED IN THE DRAFT FACILITIES PLAN

Liquid Line	Sludge Line
• Mississippi River STP Bar screen Comminutor Grit chamber Primary clarifier Step aeration Secondary clarifier Chlorination	Gravity thickener Aerobic digester or anaerobic digester, or incinerator Land application or sludge lagoon
• Missouri River STP Bar screen Comminutor Grit chamber Primary clarifier Step aeration, or Contact stabilization or Complete mix, or Plug flow, or Pure oxygen Chlorination	Gravity thickener Haul to Mississippi River STP or aerobic digester, or anaerobic digester Land application
• St. Peters/Spencer Creek STP Contact stabilization Nitrification Chlorination	Haul to Mississippi River STP or aerobic digester Land application or sludge lagoon
• Duckett Creek STP Contact stabilization or Step aeration, or Plug flow, or Oxidation ditch	Haul to Mississippi River STP or aerobic digester, or anaerobic digester, Land application or sludge lagoon
• Harvester-Dardenne STP Contact stabilization, or Step aeration, or Plug flow, Nitrification Chlorination	Haul to Mississippi River STP or aerobic digester, or anaerobic digester Land application or sludge lagoon

Source: Sverdrup & Parcel and Associates, Inc. (1983b)

Reliability takes the complexity of the treatment systems into account. The four possibilities that are feasible in the planning area are listed below beginning with the most reliable:

- Secondary treatment, little pumping
- Secondary treatment, extensive pumping
- Advanced treatment, little pumping
- Advanced treatment, extensive pumping

Flexibility refers to how easily a collection or treatment system alternative can be modified to serve a growing population. For example, it is more difficult to connect to pressure sewers than to connect to gravity sewers--if so, then gravity sewers are more flexible. Also, treatment plants that are confined by residential or commercial developments have little room for expansion, therefore, they have less flexibility than plants located in less developed areas.

Implementability refers to the political and administrative actions that are required for an alternative to be successful. For example, implementability is difficult when more than one agency must cooperate. Implementability is also difficult if voters are reluctant to authorize a regional sewer district. All these factors were considered and ranked in the facilities plan, and the results are summarized in Table 2-10. The Citizens Advisory Committee considered these rankings and recommended the top four alternatives be evaluated in detail. The four alternatives selected for detailed analysis in the facilities plan were Alternatives 3, 6, 7, and 8.

2.3.2 Description of Alternatives Selected for Detailed Analysis in the Facility Plan

The four wastewater management alternatives selected for detailed analysis in the facilities plan involve the continued use of three or four municipal STPs throughout the 20-year planning period, while the Highway 94-South STP would become an interim treatment facility under each alternative. Specific descriptions of these four "action" alternatives and the "no action" alternative are presented in the following sections. Public views, non-monetary factors, and economic factors for each final alternative were compared to arrive at the recommended facility plan alternative. In the draft facilities plan, an analysis of the four final action alternatives (Alternatives 3, 6, 7, and 8) was performed using EPA's CAPDET program. Special attention was given to types of activated sludge systems and sludge handling methods. In some cases, the costs derived by computer assistance were refined.

TABLE 2-10
RANKING OF PRELIMINARY ALTERNATIVES

EVALUATION FACTOR	ALTERNATIVE 1	2	3	4	5	6	7	8
• Monetary considerations**								
Present worth	8	6	7	5	4	1	3	2
User fees	7	8	4	6	5	1	2	3
• Environmental considerations*								
Water quality	1	3	1	3	1	1	1	1
Aesthetics, noise, odor	1	6	1	6	1	1	1	1
Recreational opportunity	3	5	3	5	3	3	3	3
• Reliability*	1	7	4	5	4	4	4	4
• Flexibility*	3	5	3	5	7	7	7	7
• Implementability*	8	7	5	3	7	1	8	5
• Unweighted total	32	47	28	38	32	19	29	26
• Relative Rank	5	7	3	6	5	1	4	2

* Low numbers reflect favorable characteristics (number is not actual rank in relation to other alternatives)

** Number is actual rank in relation to other alternatives

Notes:

Monetary considerations

(1) Ranking by present worth summary given to Advisory Group on 18 May 1983.

(2) Ranking by user fees based on preliminary calculations of new construction expenses, O&M of treatment plants, and O&M of proposed pump stations. However, the preliminary user fees do not include existing debt nor O&M of the collection systems and existing pump stations.

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1983b)

Engineering considerations and site-specific conditions weighed heavily in the selection of sludge handling options for the four action alternatives. Two filter presses and an incinerator are currently in operation at the Mississippi River Plant. The sludge handling equipment at the plant has adequate capacity to accommodate additional loads resulting from population growth in the planning area during the 20-year design period. The incinerator at the Mississippi River Plant can also handle the sludge from the Missouri River Plant. In the facilities plan, a determination was made that it was more cost-effective to transport dewatered sludge from the Missouri River Plant to the Mississippi River Plant, than to construct a sludge handling facility at the Missouri River Plant. Filter presses were selected as the best dewatering method at the Missouri River Treatment Plant for two reasons: (1) a high degree of sludge dewatering is necessary prior to incineration to allow self-sustaining combustion and a high solids cake in the range of 30 to 40% solids for raw primary sludge is required and readily provided by filter presses; and (2) operators at the Missouri River Plant are already familiar with this sludge dewatering process and have had success with the system.

Although disposal of sludge incinerator ash could continue onsite at the Mississippi River Plant, disposal of the ash in a sanitary landfill would eventually be necessary. All costs in this analysis assumed disposal of ash in a landfill.

Belt filter presses were recommended for sludge dewatering at the Spencer and Duckett Creek plants. Belt filter presses are cost-effective for plants of this size and are simple to operate and maintain. Ultimate disposal of the sludge, derived primarily from residential sources, would preferably be by land application as a soil conditioner; however, landfilling costs are essentially the same in both cases. In the facilities plan analysis, all cost estimates assumed were for land application of digested sludge; however, no comprehensive final sludge disposal plan was presented in the draft facilities plan.

The selected wastewater management option for the floodplain areas should be the most cost-effective and implementable of the available options. The one option investigated in the facilities plan was conventional gravity sewers. Because this option is high in cost and involves a long-term commitment to maintaining these communities, other options, such as onsite treatment systems, that have lower costs and a lower level of service should be investigated. The Federal Emergency Management Agency (FEMA) policies discourage construction and maintenance of residences in areas subject to frequent flooding. Flood insurance rates are based on flooding frequency and are established to discourage residential development in floodplains. The insurance program is intended to replace the need for "disaster" funding (through which individuals previously repaired their residences following floods) by discouraging development in flood-prone areas. Because other Federal programs likewise are attempting to discourage residential development in areas subject to frequent flooding, no significant investments in infrastructural improvements can be recommended.

To improve the effectiveness of wastewater management planning in these floodplain areas, establishment or expansion of an onsite management district to direct and oversee onsite system improvements should be strongly considered. This management district or agency should provide evaluations and supervision specifically for onsite system construction and maintenance so that the public health of the residents of the area is not jeopardized. The upgrading of existing onsite systems would not provide a level of protection equivalent to centralized sewers, but centralized management and upgrading of failing onsite systems in particular, would result in improved operations and reduced potential health risks. Flooding events would remain as major problem periods with onsite systems, although the centralized alternatives also could be rendered inoperable during major floods.

2.3.2.1 No Action

The "No Action" Alternative implies that no Federal, state, or local funds would be provided to build and/or upgrade wastewater management systems. Problems identified in Section 2.1 would be expected to remain unsolved, and as a result, new problems likely would develop during the 20-year planning period.

Within the City of St. Charles, the Missouri River STP is not meeting secondary effluent limitations specified in the NPDES permit established for the facility. The plant is currently overloaded, therefore, the likelihood of bypassing raw sewage to area streams, as a result of increased I/I during storm events, would increase. Both the St. Charles Trails STP and the Heatherbrook Lagoon have not consistently met their established NPDES effluent limitations. It is not likely that effluent limitations could be attained for both facilities unless some corrective action is taken. The consequences of no action would be to further degrade area streams due to the discharge of inadequately treated wastewater.

Within the City of St. Charles, the Spencer Creek STP does not consistently meet its NPDES effluent limitations for TSS. Based on the results of a waste load allocation analysis for lower Dardenne Creek, it is expected that the STP will be required to remove ammonia in order to continue discharging effluent to Dardenne Creek. Due to existing facility design, the STP is not capable of providing ammonia removal and an effluent pump would be required to convey effluent to the receiving stream during heavy rainfall events.

Within the Duckett Creek Sewer District, the Harvester-Dardenne STP, Highway 94-South STP, and Boschertown Lagoon have little, if any, excess capacity for increased wastewater flows resulting from projected future development. Based on the wasteload allocation analysis for lower Dardenne Creek, both the Harvester-Dardenne STP and Highway 94-South STP would be required to remove ammonia if they continue to discharge effluent to Dardenne Creek. Due to existing design, neither STP is capable of removing ammonia from wastewater. Without any modifications, these three treatment plants are expected to be hydraulically overloaded, resulting in further degradation of the effluent and water quality of the receiving stream. Dardenne Creek is currently being degraded due to the ammonia-nitrogen loading from the Harvester-Dardenne STP and Highway 94-South STP.

Areas served by onsite sewage treatment systems which have experienced problems, as discussed in Section 2.1.2, would be expected to continue to have problems under the no action alternative. These problems would result in the continued degradation of local area streams, as well as present a potential health hazard.

2.3.2.2 Alternative 3

Alternative 3 would involve the continued use of the Spencer Creek STP, Duckett Creek STP, Missouri River STP, and Mississippi River STP. The Highway 94-South STP would serve as an interim treatment plant. Each STP would treat wastewater conveyed from the service areas indicated in Table 2-8c and illustrated in Figure 2-6.

The Highway 94-South STP would initially be expanded and upgraded to a 1.0 mgd treatment plant with nitrification capabilities. The plant would be operated until the interceptor system is constructed in 1989, which would transport wastewater from the South subarea to the Spencer Creek STPs.

The Spencer Creek STP would be expanded to an 7.5 mgd secondary treatment plant. As indicated in Table 2-11, the existing treatment plant would be converted to a contact stabilization activated sludge plant. An effluent chlorination system, effluent pump, and outfall to the Mississippi River would be constructed. Selected sludge treatment and disposal options, also summarized in Table 2-11, would require construction of gravity thickeners and an aerobic digestion system and installation of belt filter presses to dewater the sludge. Dewatered sludge would be disposed of by land application.

The existing Duckett Creek STP would be replaced by a new 1.0 mgd secondary treatment plant constructed on the existing plant site. The new facility would be an oxidation ditch activated sludge system with effluent discharged to Duckett Creek, as indicated in Table 2-11. New sludge treatment units would consist of gravity thickeners, anaerobic digesters, and belt filter presses. As summarized in Table 2-11, sludge would be disposed of by land application.

The Missouri River STP would be expanded and upgraded from a 3.0 mgd primary facility to a 5.0 mgd secondary treatment plant. Table 2-11 summarizes the selected liquid treatment and disposal options which include the expansion of the existing primary treatment system and construction of an oxidation ditch system. Treated effluent would continue to be discharged by gravity to the Missouri River. The selected sludge treatment and disposal options, also summarized in Table 2-11, include construction of gravity thickeners and the addition of belt filter presses for sludge dewatering. The dewatered sludge would be hauled to the Mississippi River STP for incineration.

The Mississippi River STP would be expanded from a 5.5 mgd to a 7.0 mgd secondary treatment plant. As indicated in Table 2-11, the plant would continue to consist of primary sedimentation, step aeration activated sludge system, with chlorinated effluent flowing by gravity to the Mississippi River. Existing sludge treatment facilities would continue to be utilized. As indicated in Table 2-11, sludge facilities consist of gravity filters, filter presses, and an incineration system. Disposal of incinerator ash would continue onsite but would eventually be sent to a sanitary landfill.

TABLE 2-11
SUMMARY OF SELECTED WASTEWATER AND SLUDGE TREATMENT/DISPOSAL OPTIONS EVALUATED IN THE DRAFT FACILITIES PLAN

LIQUID STREAM

Alternative Number(s)	STP	Activated Sludge Treatment Scheme	Disinfection	Effluent Disposal
3, 6, 8	Spencer Creek STP	Contact Stabilization	Chlorination	Pump to Mississippi River
3, 6, 7, 8	Duckett Creek STP	Oxidation Ditch	None	Gravity Flow to Duckett Creek
3, 6, 7, 8	Missouri River STP	Primary Sedimentation/ Oxidation Ditch	None	Gravity Flow To Missouri River
3	Mississippi River STP	Primary Sedimentation/Step Aeration	Chlorination	Gravity Flow to Mississippi River
6, 7, 8	Mississippi River STP	Primary Sedimentation/Step Aeration	Chlorination	Pump to Mississippi River

SLUDGE STREAM

Alternative Number(s)	STP	Sludge Stabilization	Sludge Thickening	Sludge Dewatering	Sludge Disposal
3, 6, 8	Spencer Creek STP	Aerobic Digestion	Gravity Thickeners	Belt Filter Press	Land Application
3	Duckett Creek STP	Anaerobic Digestion	Gravity Thickeners	Belt Filter Press	Land Application
6, 7, 8	Duckett Creek STP	Aerobic Digestion	Gravity Thickeners	Belt Filter Press	Land Application
3, 6, 7, 8	Missouri River STP	None	Gravity Thickeners	Filter Press	To Miss. River STP
3, 6, 8	Mississippi River STP	Incineration	Gravity Thickeners	Filter Press	Landfill (Ash)
7	Mississippi River STP	Aerobic Digestion/ Incineration	Gravity Thickeners	Belt Filter Press	Landfill (Ash)

2.3.2.3 Alternative 6 (Facility Plan Recommended Alternative)

Alternative 6 would involve the continued use of the Spencer Creek STP, Duckett Creek STP, Missouri River STP, and Mississippi River STP. As in Alternative 3, the Highway 94-South STP would serve as an interim facility. Table 2-8f summarizes the sewer subareas served by each treatment plant and Figure 2-9 illustrates the proposed interceptor configuration.

Both Alternatives 3 and 6 are similar since the Highway 94-South STP would initally be expanded and upgraded to a 1.0 mgd treatment plant. The plant would be operated until the interceptor system that would transport wastewater from the South Subarea to the Duckett Creek STP is constructed in 1989. The Spencer Creek STP would be upgraded, as described for Alternative 3 as summarized in Table 2-11. However, under Alternative 6, the plant would be expanded to a 4.0 mgd facility.

The existing Duckett Creek STP would be replaced by a new 5.0 mgd secondary treatment plant constructed on the existing plant site. The selected liquid treatment/disposal options are the same as those described for Alternative 3 and summarized in Table 2-11. As indicated also in Table 2-11, the only difference between the selected sludge treatment/disposal options under Alternatives 3 and 6 is that sludge stabilization would be by aerobic digestion in Alternative 3 rather than by anaerobic digestion in Alternative 6. The Missouri River STP would be expanded and upgraded as described under Alternative 3. As indicated in Table 2-11, there is no difference between any of the "action" alternatives.

The Mississippi River STP would be expanded and upgraded to a 7.0 mgd secondary treatment plant. The expansion and upgrade scheme is similar to that described under Alternative 3. As indicated in Table 2-11, the only major difference between Alternative 3 and 6 is that under Alternative 3, effluent would flow by gravity rather than be pumped to the Mississippi River.

2.3.2.4 Alternative 7

Alternative 7 would involve the continued use of the Duckett Creek STP, Missouri River STP, and Mississippi River STP. As in the previously described "action" alternatives, the Highway 94-South STP would serve as an interim facility. Table 2-8g summarizes the sewer subareas served by each treatment plant and Figure 2-10 illustrates the proposed interceptor configuration.

The Highway 94-South STP would be expanded and upgraded as described in the previously presented "action" alternatives. However, the plant would be abandoned in 1995, when the interceptor system would be constructed to convey wastewater to the Mississippi River STP. One major difference between the previously described "action" alternatives and Alternative 7, is that the Spencer Cre[illegible]TP would be abandoned in 1995 under Alternative 7 rather than remain operational throughout the 20-year planning period under the former alternatives. As indicated in Figure 2-10, the Spencer Creek STP would become a pump station and wastewater would be pumped to the Mississippi River STP for treatment.

The Duckett Creek STP would be replaced by a new 3.5 mgd secondary treatment plant constructed on the existing plant site. The treatment plant scheme would consist of the same treatment/disposal options for wastewater and sludge that was developed in Alternative 6 (see Table 2-11).

The Missouri River STP would be expanded and upgraded as described under Alternative 3. As indicated in Table 2-11, there is no difference between any of the "action" alternatives.

The Mississippi River STP would be expanded and upgraded to a 12.0 mgd secondary treatment plant. The upgrade scheme is similar to that described under Alternative 6. As indicated in Table 2-11, the only major difference between Alternative 6 and Alternative 7 is that under the latter alternative, sludge is aerobically digested, while under the former alternative, sludge is not digested.

2.3.2.5 Alternative 8

Alternative 8 would involve the continued use of the Spencer Creek STP, Duckett Creek STP, Missouri River STP, and Mississippi River STP. As in the previously described "action" alternatives, the Highway 94-South STP would serve as an interim facility. Table 2-8h summarizes the sewer subareas served by each treatment plant and Figure 2-11 illustrates the proposed interceptor configuration.

The Highway 94-South STP would be expanded and upgraded as described in the previously presented "action" alternatives. However, the plant would be abandoned in 1995, when the interceptor system would be constructed to convey wastewater to the Spencer Creek STP. The Spencer Creek STP would be upgraded, as described for Alternative 3 and summarized in Table 2-11. Under Alternative 8, the plant would be expanded to a 5.0 mgd facility. The Duckett Creek STP would be replaced by a new 3.5 mgd facility, as described for Alternative 7. There is no difference between the Duckett Creek STP replacement plant developed under Alternatives 7 and 8 (see Table 2-11). The Missouri River STP would be expanded and upgraded to 5.0 mgd as described under the other "action" alternatives.

The Mississippi River STP would be expanded to a 7.0 mgd facility, as described under Alternative 6. There is no difference between the Mississippi River STP expansion developed under Alternative 6 and Alternative 8 (see Table 2-11).

2.3.3 Comparison of Final System Alternatives

This section presents preliminary construction, operation and maintenance costs for the four final sewage conveyance and treatment alternatives identified in previous sections. Economic analyses were based on a 20-year design period. Projected wasteloads and flows for the year 2005 were used to size sewer lines, pumping stations, and treatment facilities. A discount rate of 8% over a 20-year period was used during facilities planning to determine present worth and uniform annual equivalent costs for the economic analysis.

Cost estimates were only one of the factors used in the detailed evaluation of alternatives. Non-monetary factors such as environmental, reliability, flexibility, and implementability were also considered. This section briefly addresses each of these factors.

2.3.3.1 Cost-Effectiveness Analysis

A summary of CAPDET costs for comparison purposes is shown in Table 2-12. Project operation and maintenance costs are shown for each of the four final action alternatives. Present worth values are also presented. The values

TABLE 2-12
EVALUATION OF COSTS FOR THE FOUR FINAL ALTERNATIVES

	Alternative (Million $)			
	3	6	7	8
PROJECT COST				
1. Treatment	34.4	34.0	31.3	36.2
2. Transmission	10.8	7.4	19.3	7.9
3. Total	45.2	41.4	50.6	44.1
ANNUAL O&M COST				
1. Treatment	1.69	1.66	1.64	1.74
2. Transmission	0.11	0.18	0.23	0.15
3. Total	1.80	1.84	1.87	1.89
TOTAL PROJECT COST	45.2	41.4	50.6	44.1
TOTAL PRESENT WORTH*	51.4	46.0	50.5	47.3
APPROXIMATE LOCAL SHARE				
1. Duckett Creek Sewer District				
Capital	4.10	8.25	5.05	5.90
O&M	0.34	0.66	0.54	0.60
2. St. Charles				
Capital	9.04	9.04	12.61	9.04
O&M	0.90	0.80	0.92	0.80
3. St. Peters				
Capital	11.12	4.43	9.27	8.54
O&M	0.66	0.38	0.41	0.49

* The present worth analysis uses an 8% discount rate over a 20-year planning period and considers salvage value of equipment for the staged construction of the projects.

These values are for comparative purposes only. Several project items that are common to all alternatives are not included in the cost figures. These include construction of an interim south area treatment plant and a few interceptors. Absolute costs may be higher than those indicated in the table.

Source: Sverdrup & Parcel and Associates, Inc. (1984)

shown in the table do not include costs for facilities that are common to all alternatives. The cost assessments that went into this summary table are summarized below.

Gravity Sewers and Force Mains

Costs were developed for gravity sewer lines and force mains for various pipe sizes per foot of installed sewer. Cost estimates were based on the EPA document: Construction Costs for Municipal Wastewater Conveyance Systems: 1973-1977. Costs were updated to January 1983 dollars based on the EPA complete urban sewer system (CUSS) index, and adjusted for the St. Louis area. Further cost adjustments were made to reflect recent St. Louis area bid prices. The costs for each lineal foot of sewer line included total construction costs. Gravity line costs included pipe, trenching and backfilling, standard and drop manholes, street and stream crossings, standard and special bedding, rock excavation, pavement removal and replacement, and utility disconnection and reconnection. Force main costs included pipe, excavation, thrust blocks, cleanout manholes, air release valves, pavement removal and replacement, and utility disconnection and reconnection.

Pumping Stations

Pump design capacities were based on projected 2005 peak flows. Three types of pumping stations were considered in the cost analysis: submersible pumping stations, wet well/dry well pumping stations, and screw pumping stations. Preliminary construction costs were based on three EPA publications: Construction Costs for Wastewater Conveyance: 1973-1977, Innovative and Alternative Technology Assessment Manual, and Cost of Land Treatment Systems. Cost was updated to January 1983 dollars and adjusted to reflect recent bid prices in the St. Louis area. Operation and maintenance costs were based mainly on cost curves from Appendix A of EPA's Innovative and Alternative Technology Assessment Manual and were adjusted to reflect anticipated pumping heads.

Treatment Plants

Cost estimates utilized for treatment plants employed the Computer-Assisted Procedure for the Design and Evaluation of Wastewater Treatment Systems (CAPDET) developed by the EPA and Department of the Army. The computer program enabled the analysis of a large number of alternative wastewater treatment systems. CAPDET was used to screen various wastewater and sludge treatment methods for all the action alternatives. This screening was performed in two steps: (1) without consideration of staged construction, and (2) with consideration of staged construction. Each of the eight preliminary alternatives consists of a different combination of service areas and treatment plant locations. Each alternative contains from three to five treatment plants.

The cost estimates developed during the first step considered a wide variety of unit processes for each plant, as initially selected in Section 2.2.2. Unit processes were arranged in various combinations so that from 2 to 20 treatment schemes were evaluated for each treatment plant. The least expensive treatment scheme for each plant was used to determine the effects of staged construction on the eight action alternatives. The costs developed by CAPDET for the treatment schemes were combined with the costs for sewers and pump stations. These preliminary costs, which indicated capital, operation and maintenance, and present worth costs for each treatment plant, pump station, and transmission system ranged from $37,070,000 to $62,470,000.

In addition, an analysis was performed on the cost-effectiveness of replacing the Missouri River STP with a pumping station and force main. Wastewater would be pumped to the Mississippi River STP for treatment. The present worth analysis indicated that it would be more economical to treat flows from the Missouri River service area at a new secondary facility than to construct a pumping station and force main and treat the wastewater at an expanded Mississippi River STP. Based on this finding, pumping the Missouri River STP wastewater to the Mississippi River STP was not considered a viable plan.

It was also determined in the facilities plan that it was cost-effective to pump the Spencer Creek STP effluent to the Mississippi River, rather than upgrading the plant to include nitrification with the effluent discharging into Spencer Creek. All alternatives that include a Spencer Creek treatment facility also include an effluent pumping station and force main to the Mississippi River.

2.3.3.2 Non-Monetary Factors

Non-monetary factors used in comparing alternatives included reliability, environmental effects, floodplain infringement, energy use, public approval, implementation capability, contribution to goals, and expandability. Environmental consequences from the construction and operation of the four final action alternatives and the no action alternative, are discussed in detail in Section 4.0.

Floodplain infringement would result from the construction of any of the four final alternatives. Alternatives 3, 6, and 8 would require force main easements from the St. Peters STP site to the Mississippi River discharge point. Alternative 7 would require force main easements from the St. Peters STP site to the St. Charles Mississippi River STP. Each alternative also would require limited land acquisition at existing treatment plant sites, some of which are in the floodplain. Impacts of the various alternatives upon wetlands and floodplains are discussed in Section 4.2.1.6 of this document.

The results of a primary energy analysis using CAPDET output and engineering estimates for each of the alternatives are shown in Table 2-13. Alternative 7 would have lowest energy use. This primarily is due to converting the treatment plant at St. Peters to a pumping station. The pumping station would use much less energy than an activated sludge plant. Also, with Alternative 7, the St. Charles Mississippi River STP sludge incinerators and filter presses would be replaced by aerobic digesters and belt filter presses, saving additional energy. Alternatives 6 and 8 are comparable to Alternative 3 which requires slightly less energy due to a lower pumping head at the Harvester-Dardenne pump system. Pumping wastewater to the St. Peters collection system would result in the use of smaller pumps rather than pumping over a ridgeline to the Duckett Creek STP, as would be required in Alternatives 6 and 8.

2.3.3.3 Implementability

Implementability refers to the political and administrative actions that are required for an alternative to be successful. For example, implementability is difficult when more than one agency must cooperate. Implementability is also difficult if voters are reluctant to authorize a regional sewer district.

TABLE 2-13

PRIMARY ENERGY ANALYSIS

Alternative	Energy Cost*	Rank
3	$872,000	2
6	929,000	3
7	653,000	1
8	931,000	4

* It should be noted that several energy cost items that are common to all alternatives are not included in the cost figures. Absolute costs may be higher than those indicated in the table. These values are for comparative purposes only.

Source: Sverdrup & Parcel and Associates, Inc. (1983b)

Implementation of each alternative is a key issue because of political impacts on the three existing sewer agencies. Alternatives 3 and 8 combine the St. Peters and Duckett Creek service areas, while leaving St. Charles with its existing service areas. Alternative 7 combines the St. Peters and St. Charles service areas. The City of St. Charles has expressed opposition to any plan to serve other than their existing service area with their treatment facilities. St. Charles has sized their facilities for future growth and does not wish to subsidize wastewater treatment for other areas. With Alternative 6, each agency would retain its current service areas, and this alternative is supported by the Duckett Creek Sewer District, and the cities of St. Peters and St. Charles.

All four final alternatives would contribute to the goal of reducing pollution in the planning area. Each wastewater treatment option considered in the draft facilities plan is capable of meeting effluent limitations. The ability to expand wastewater treatment and collection/conveyance facilities in the future is an important consideration in ranking service area and treatment plant alternatives. Generally, for all alternatives, the proposed treatment facilities could be readily expanded. Alternatives with extensive pumping, such as Alternative 7 (where flow is pumped from St. Peters to the Mississippi River Plant), would be more difficult to expand. Finally, public opinion is not expected to differ substantially among the four final alternatives considered in the facilities plan; all action alternatives generally should be acceptable to the public.

2.3.4 Description of Facility Plan Recommended System Alternative

The intent of this section is to describe the components associated with the facilities plan recommended alternative. A discussion of the proposed plans for onsite systems, private systems, and small systems outside the planning area also are discussed and cost estimates for all of the proposed improvements are presented.

In the facilities plan, Alternative 6 was selected as the most cost-effective system that would satisfy both the needs and requirements of the Duckett Creek Planning Area and fulfill environmental and regulatory requirements. Alternative 6 consists of expanding the Mississippi River and

Spencer Creek STPs, constructing new facilities at the Missouri River and Duckett Creek STPs, and upgrading the wastewater collection and transmission system. Further, construction also would begin in the near future and various stages of the overall plan would be put into effect at different times during the 20-year planning period. The implementation schedule is presented in Figure 2-14.

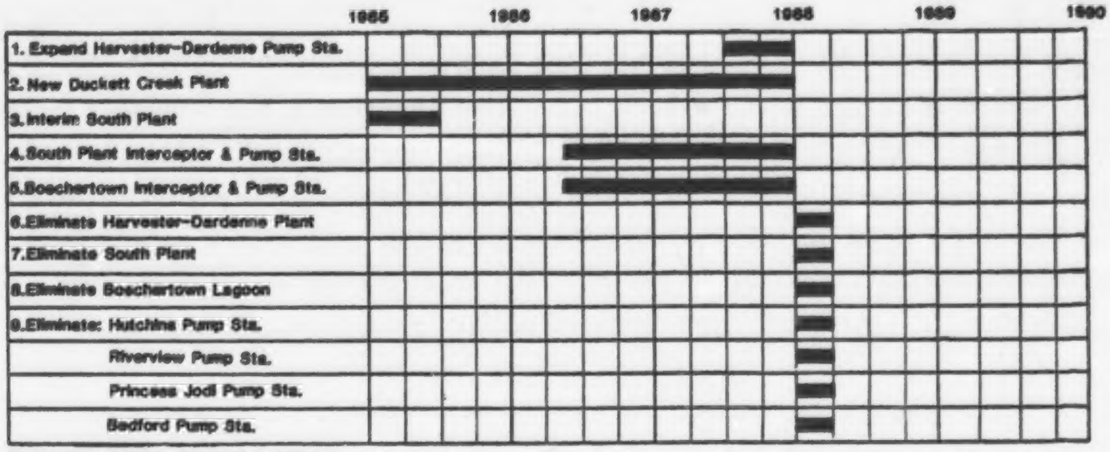
2.3.4.1 Wastewater Collection and Conveyance Facilities

The proposed gravity interceptors, force mains, and pumping stations required for Alternative 6 are illustrated in Figure 2-9 (page 2-73). Four major interceptor routes are proposed: (1) South Plant to the Harvester-Dardenne site; (2) Spencer Creek STP to the Mississippi River; (3) Boschertown lagoon to the Missouri River STP; and (4) St. Charles Trails STP to I-70.

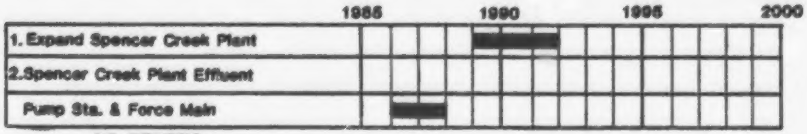
Wastewater flows pumped from the South Plant service area would be intercepted by a gravity sewer. The sewer line would follow Dardenne Creek to a pumping station north of the Harvester-Dardenne STP where the wastewater would be pumped to the Harvester-Dardenne pumping station (see Figure 2-9). The Harvester-Dardenne pumping station would pump both the South Plant and the Harvester-Dardenne service area flows to the new 5 mgd Duckett Creek STP. Once the downstream treatment facilities are constructed the interim South Plant would be eliminated. Effluent from the Spencer Creek STP will be pumped into the Mississippi River. The force main would follow Spencer Creek and then run northward, across the floodplain, to the Mississippi River.

The Boschertown interceptor would run from the Boschertown lagoon to the Missouri River STP. Gravity sewers would be used with an intermediate lift station. This interceptor would eliminate the Boschertown lagoon and the Hutchins, Riverview, Princess Jodi, and Bedford pumping stations.

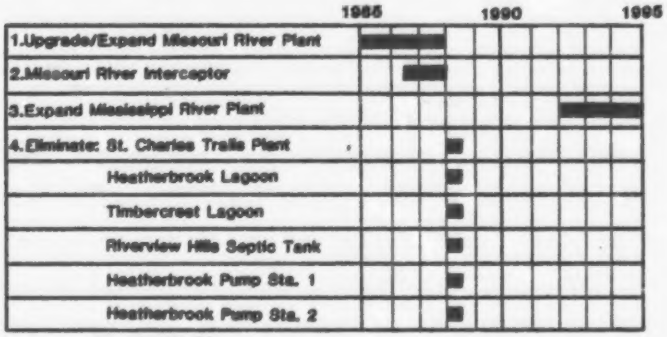
The Missouri River interceptor stops at I-70. An extension of this sewer line would eliminate the St. Charles Trails STP, Timbercrest and Heatherbrook lagoons, Riverview Hills septic tank and sand filter, and Heatherbrook pumping stations numbers 1 and 2. The alignment of the sewer line would run from the St. Charles Trails STP along Taylor Branch, and then follow the MK&T Railroad to the existing Missouri River interceptor.



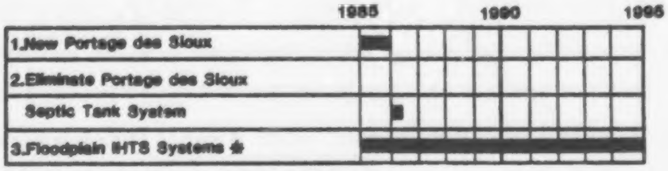
DUCKETT CREEK SEWER DISTRICT
PRELIMINARY IMPLEMENTATION



ST. PETERS
PRELIMINARY IMPLEMENTATION



ST. CHARLES
PRELIMINARY IMPLEMENTATION



PORTAGE DES SIOUX AND FLOODPLAIN
PRELIMINARY IMPLEMENTATION

* Continue Projects as Funding Becomes Available

FIGURE 2-14. PROPOSED IMPLEMENTATION SCHEDULE FOR FACILITY PLAN RECOMMENDED ALTERNATIVE.

2.3.4.2 Wastewater and Sludge Treatment Facilities

Mississippi River Plant

The Mississippi River STP would be expanded from a capacity of 5.5 mgd to 7.0 mgd. The existing unit processes would be maintained; however, expansion or replacement of certain items would be required. The mechanically-cleaned bar screen installed in 1968, would be replaced by a similar piece of equipment during the planning period. The existing raw sewage pumps would be replaced with centrifugal type pumps, sized for peak flow.

The aerated grit chamber also would be replaced. The existing blowers could be used with the new, smaller grit chamber. It may be possible to modify the existing grit chamber or salvage the grit dragout system; however, these decisions should be made during final design.

Three existing primary clarifiers were recommended to be supplemented by two additional clarifiers of similar size and design. Two additional clarifiers are necessary to comply with State design guidelines on overflow rates at peak flow.

The existing aeration tanks can handle the additional waste load. Detention times would be shortened, but should not pose a problem. The existing blowers also are adequate. One additional final clarifier would be required. One additional clarifier would be sufficient to meet State guidelines for peak flow overflow rates. The existing chlorination system is inadequate and a contact chamber and additional chlorine feed equipment capacity would be required. All of the sludge handling equipment was determined to have sufficient reserve capacity to meet future needs.

A new effluent pumping station would be required. Currently, when the Mississippi River is at high stage, effluent wastewater must be pumped through an empty activated carbon filter to provide enough head to allow gravity flow to the river. The new pumping station would contain three centrifugal sewage pumps and would pump effluent through a force main to the river.

The entire plant requires an alternate source of electrical power for emergency conditions. This would be provided by generators or two separate commercial power feed lines. The City of St. Charles is having this situation studied and should have emergency power for their treatment plants soon. A preliminary plant layout showing the existing plant and proposed improvements is illustrated in Figure 2-15.

Missouri River Plant

The Missouri River STP would be expanded from a 3 mgd primary facility to a 5 mgd secondary system. The plant was built in 1966 and most of the mechanical equipment would require replacement. The Missouri River STP would require a mechanical bar screen to remove trash from the wastewater to protect equipment and prevent interference with downstream treatment processes.

The two existing sewage pumps would be replaced by three new centrifugal pumps. A new pumping station would be constructed to house the new pumps and mechanical bar screen. It is proposed that the existing detritus tank be replaced by a new aerated grit chamber.

Two additional primary clarifiers would be needed to supplement the two original primary clarifiers. The mechanical equipment in the existing clarifiers also would need to be replaced, but the concrete tanks should be salvageable.

An oxidation ditch system is proposed to provide secondary treatment. Two parallel ditches would be required with return sludge pumping. An intermediate primary effluent lift station also would be needed to pump to the oxidation ditch system and allow gravity flow to the Missouri River.

Two final clarifiers would be required following the oxidation ditches. Some of the solids that are removed would be returned to the oxidation ditches, while the remaining solids would be sent to the sludge handling system. The existing sludge handling system at the Missouri River STP currently is not used; however, the building could be modified to house the new sludge dewatering equipment.

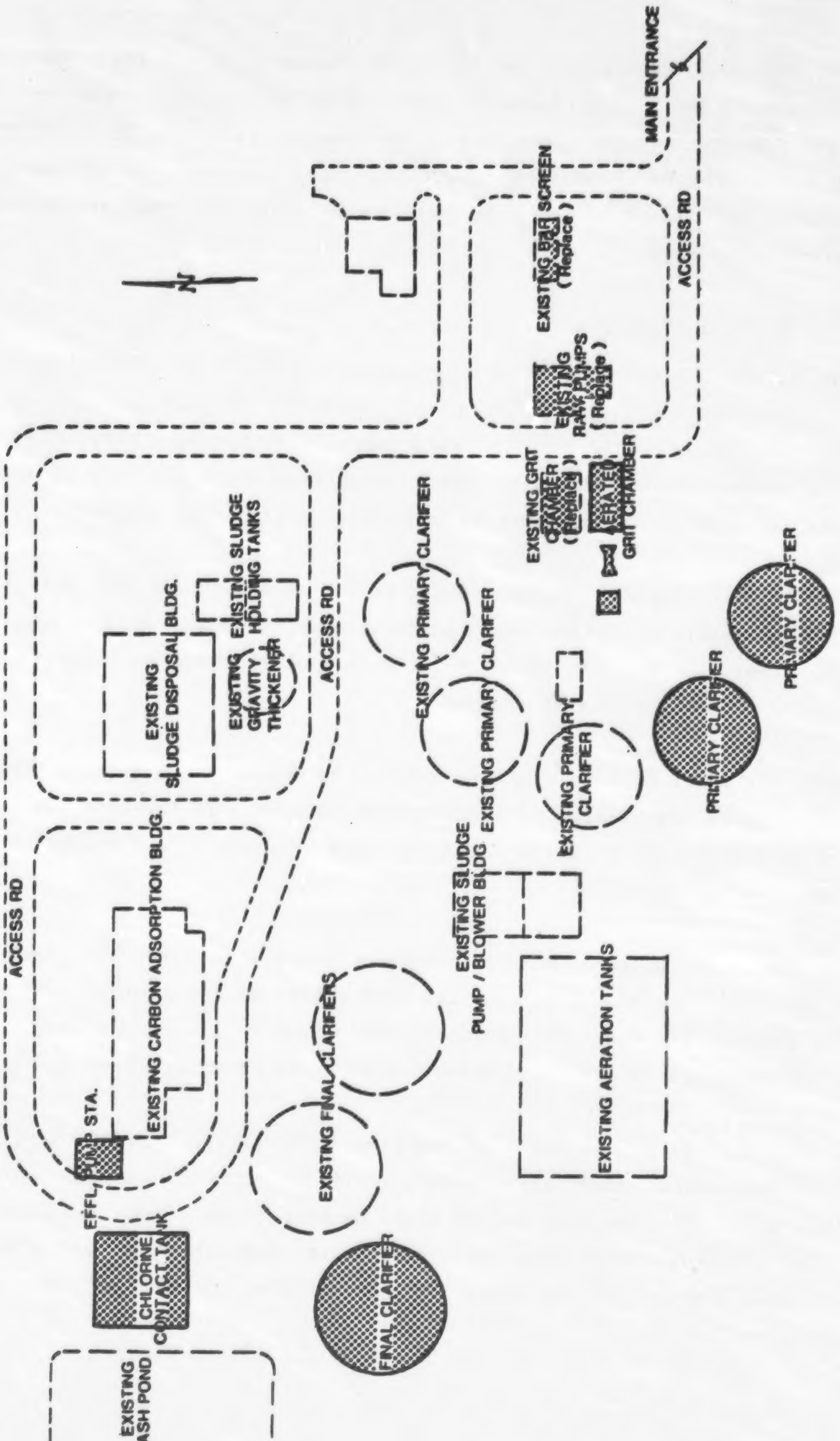

MAIN ENTRANCE
ACCESS RD
EXISTING BAR SCREEN
(Replace)
EXISTING RAW PUMPS
(Replace)
EXISTING GRIT CHAMBER
(Replace)
AERATED GRIT CHAMBER
N
EXISTING PRIMARY CLARIFIER
EXISTING SLUDGE HOLDING TANKS
EXISTING GRAVITY THICKENER
EXISTING SLUDGE DISPOSAL BLDG.
ACCESS RD
PRIMARY CLARIFIER
PRIMARY CLARIFIER
EXISTING PRIMARY CLARIFIER
EXISTING PRIMARY CLARIFIER
EXISTING PRIMARY CLARIFIER
EXISTING SLUDGE PUMP / BLOWER BLDG
EXISTING CARBON ADSORPTION BLDG.
ACCESS RD
EFFL. PUMP STA.
EXISTING AERATION TANKS
EXISTING FINAL CLARIFIERS
EXISTING FINAL CLARIFIER
FINAL CLARIFIER
CHLORINE CONTACT TANK
EXISTING ASH POND

Figure 2-15. Mississippi River STP proposed schematic.

A gravity thickener is proposed to thicken primary and secondary sludge prior to dewatering with two new filter presses and associated chemical conditioning equipment. The filter presses, similar to those used at the Mississippi River STP, would be housed in the existing sludge building. Once the sludge is dewatered, the cake would be trucked to the Mississippi River STP for incineration.

Changes in the existing yard piping would be required along with modifications to the existing buildings. Also, as mentioned for the Mississippi River Plant, an emergency power source would be required for operational reliability. Most laboratory work would still be performed at the Mississippi River STP. Provisions for simple onsite tests would be made. A preliminary plant layout showing the existing plant and proposed improvements is shown in Figure 2-16.

Duckett Creek Plant

The 1 mgd Duckett Creek package plant would be replaced by a 5 mgd treatment facility. None of the existing equipment would be used at the new plant. A mechanically-cleaned bar screen, integral with a new raw sewage pumping station and building, would be the first step in the treatment process. Three centrifugal sewage pumps would be used to lift the sewage for gravity flow through the treatment plant. Next, an aerated grit chamber would be used to remove sand and heavy inorganic solids from the wastewater. Bypass provisions and a Parshall flume to measure the flow would also be provided.

Two oxidation ditches, operated in parallel, would provide secondary treatment and aeration rotors would provide the necessary oxygen. Two final clarifiers would be required to remove solids from the wastewater prior to discharge to Duckett Creek. A sludge pumping system would recycle activated sludge to the oxidation ditches. Waste sludge would be conveyed to the sludge handling system.

Waste activated sludge would be thickened in a gravity thickener prior to stabilization in two aerobic digesters. The digested sludge would then be dewatered by two belt filter presses. The belt filter presses and chemical conditioning equipment would be housed in a sludge treatment building.

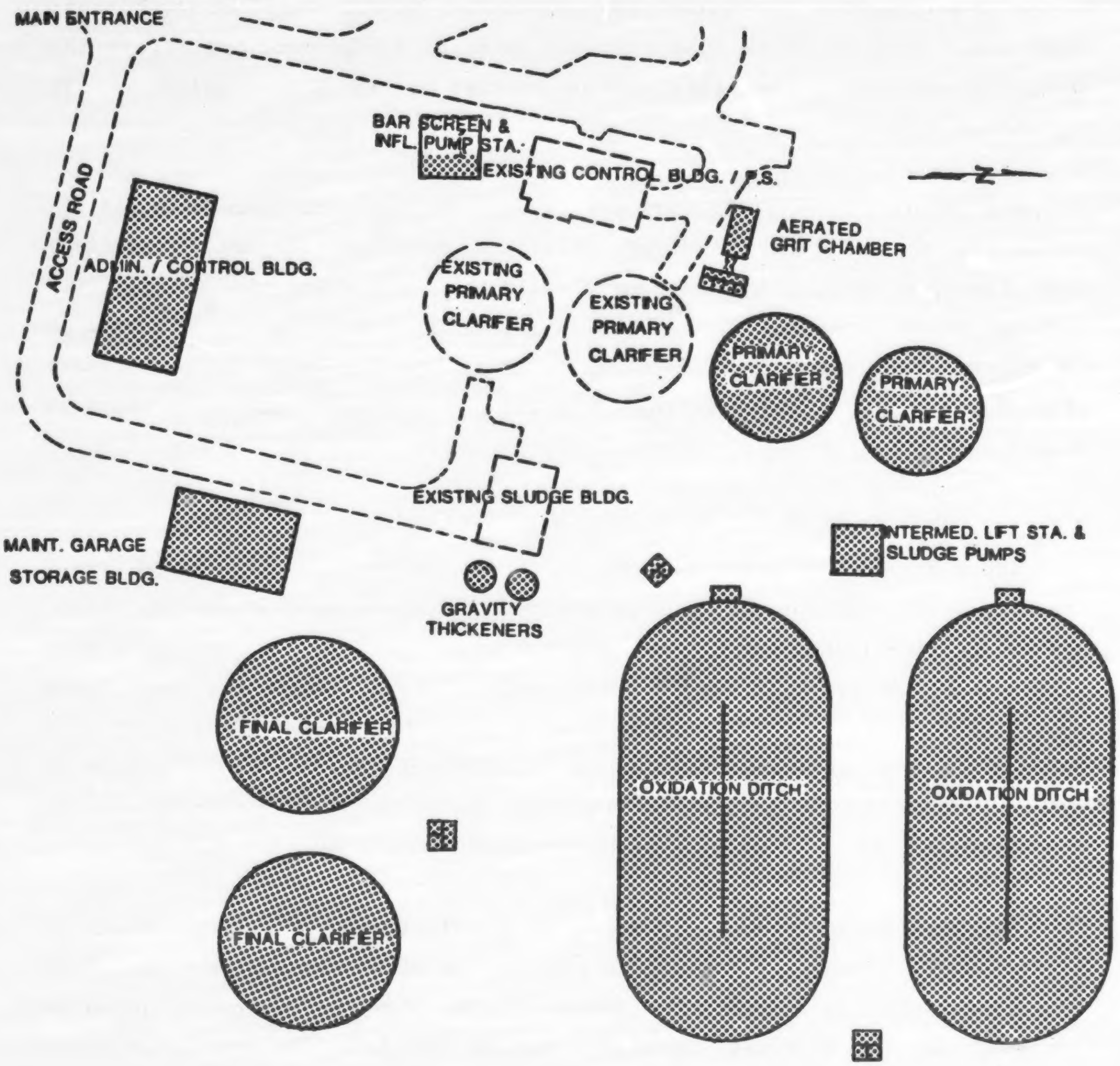

MAIN ENTRANCE
ACCESS ROAD
BAR SCREEN & INFL. PUMP STA.
EXISTING CONTROL BLDG. / P.S.
Z
AERATED GRIT CHAMBER
ADMIN. / CONTROL BLDG.
EXISTING PRIMARY CLARFIER
EXISTING PRIMARY CLARFIER
PRIMARY CLARFIER
PRIMARY CLARFIER
EXISTING SLUDGE BLDG.
INTERMED. LIFT STA. & SLUDGE PUMPS
MAINT. GARAGE
STORAGE BLDG.
GRAVITY THICKENERS
FINAL CLARFIER
OXIDATION DITCH
OXIDATION DITCH
FINAL CLARFIER

Figure 2-16. Missouri River STP proposed schematic.

Ultimate disposal of dewatered sludge would be by land application, when possible. Sufficient (30-day) cake storage facilities and alternate sludge disposal methods, including landfilling, would be necessary. Most of the farms that could utilize wastewater sludge are located in the Mississippi River and Missouri River floodplains. Availability of private sites for land application of sludge may be difficult to ascertain. Farm demand may vary, and odor problems, spreading/application problems, or any adverse publicity could disrupt the working arrangement. A more flexible system was therefore proposed. The proposed plan includes onsite storage, land application of sludge to the greatest extent possible, or landfilling of sludge cakes. Final application sites currently are not known, but would be selected during the project design stage.

Sludge disposal facilities and equipment would include a sludge storage shed for the dewatered cake and a land application truck and a feeder tank truck would be required for farmland subsurface injection. Sludge cake would be produced when land application is not feasible and stored until it could be applied to land or until storage capacity is reached, whereby the sludge would be hauled to a landfill for disposal.

A process control and laboratory building also would be required. In addition, an alternate power source for emergency situations would be necessary. Two separate commercial power feed lines would be provided. A schematic of the proposed plant layout showing the existing plant and proposed improvements is presented in Figure 2-17.

Spencer Creek Plant

The Spencer Creek STP would require upgrading from a 3 mgd extended aeration plant to a 4.0 mgd contact stabilization plant. Much of the existing equipment was installed in 1980 and could be utilized in this upgrading plan.

The raw sewage screw pumps and bar screens are in good condition and could accommodate wastewater flows to the year 2005. A new aerated grit chamber is proposed for removal of sand and heavy inorganic solids. The existing aeration tank would be modified by converting it to a smaller contact stabilization unit with diffused aeration. This process would be more energy efficient than extended aeration with surface aerators.

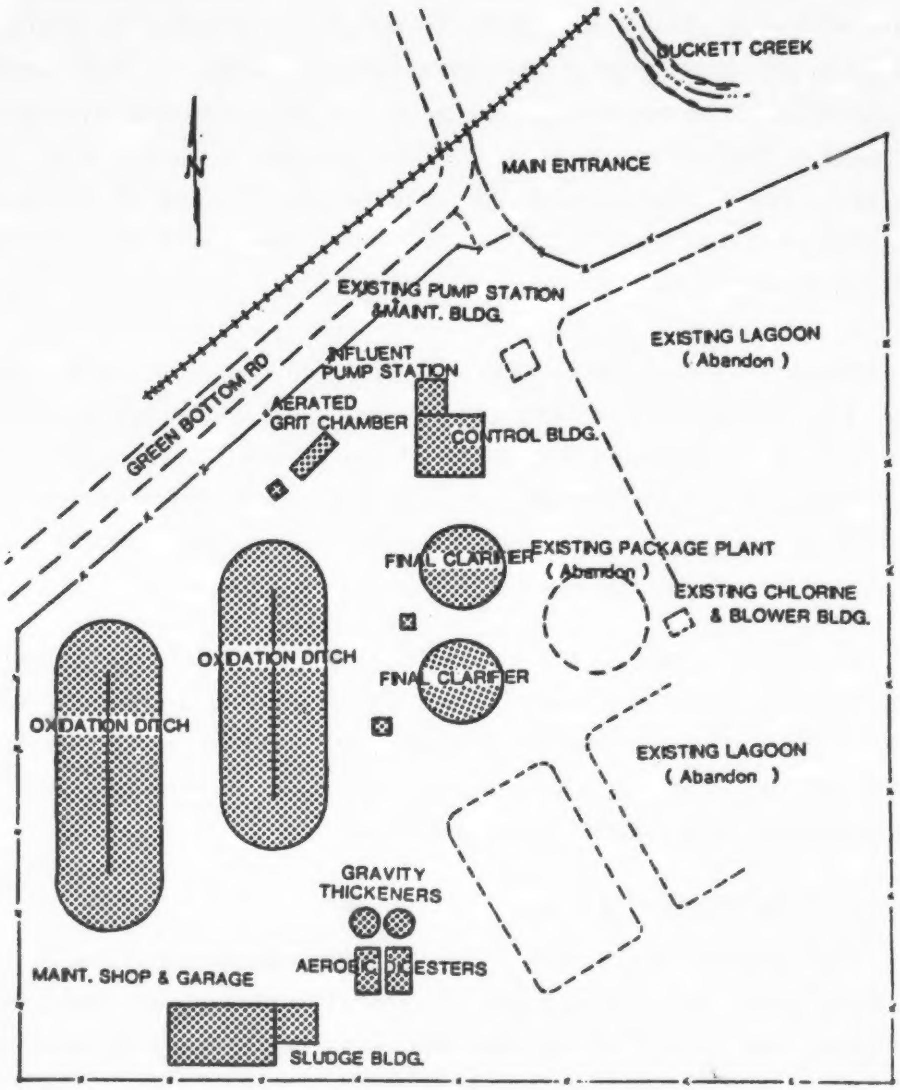

DUCKETT CREEK
N
MAIN ENTRANCE
EXISTING PUMP STATION
& MAINT. BLDG.
GREEN BOTTOM RD
INFLUENT
PUMP STATION
AERATED
GRIT CHAMBER
CONTROL BLDG.
EXISTING LAGOON
(Abandon)
FINAL CLARIFIER
EXISTING PACKAGE PLANT
(Abandon)
EXISTING CHLORINE
& BLOWER BLDG.
OXIDATION DITCH
FINAL CLARIFIER
OXIDATION DITCH
EXISTING LAGOON
(Abandon)
GRAVITY
THICKENERS
MAINT. SHOP & GARAGE
AEROBIC DIGESTERS
SLUDGE BLDG.

Figure 2-17. Duckett Creek STP proposed schematic.

The existing final clarifiers would be able to handle any additional flows. The return sludge pumping system also would have adequate reserve capacity to handle the additional sludge. Whereas any discharge to the Mississippi River requires chlorination during summer months, a contact chamber and chlorination system would be added. The effluent pumping station would have three centrifugal sewage pumps which should eliminate back-up of the gravity effluent line and flooding problems experienced by the plant during wet weather. Also, pumping the effluent to the Mississippi River would eliminate the need for nitrification, which would be required if discharge to Spencer Creek was continued.

To handle sludge, a gravity thickener would be added prior to aerobic digestion. Two new diffused air digesters would replace the original digester, which uses a 40-hp surface aerator. Digested sludge would be dewatered by two belt filter presses housed in a new sludge handling building.

The City of St. Peters is investigating land application of sludge since the existing sludge handling method (lagoon) is not acceptable. The use of a landfill is being considered as an alternate sludge disposal method. A flexible system, including storage facilities for dewatered cake, would also be required.

The Spencer Creek STP has a 500-KW electric generator sufficient for standby power during emergency situations. The existing laboratory also is sufficient and would require no upgrading. A schematic of the preliminary plant layout showing existing plant and proposed improvements is shown in Figure 2-18.

Interim South and Duckett Creek Plants

In the draft facilities plan, an interim South Plant was determined to be needed to treat wastewater from the upper Dardenne watershed until the flow could be intercepted and pumped to the new Duckett Creek STP. Further, the existing package plant, with a capacity of 80,000 gallons per day, could not handle the flow increases anticipated during the construction of the interceptor system and the new Duckett Creek STP. As of July, 1984, the flow at the South Plant was 60,000 gpd, with additional subdivisions preparing to connect to the system. Whereas the Duckett Creek Plant construction is not scheduled for completion until 1988, expansion at the South Plant is required,

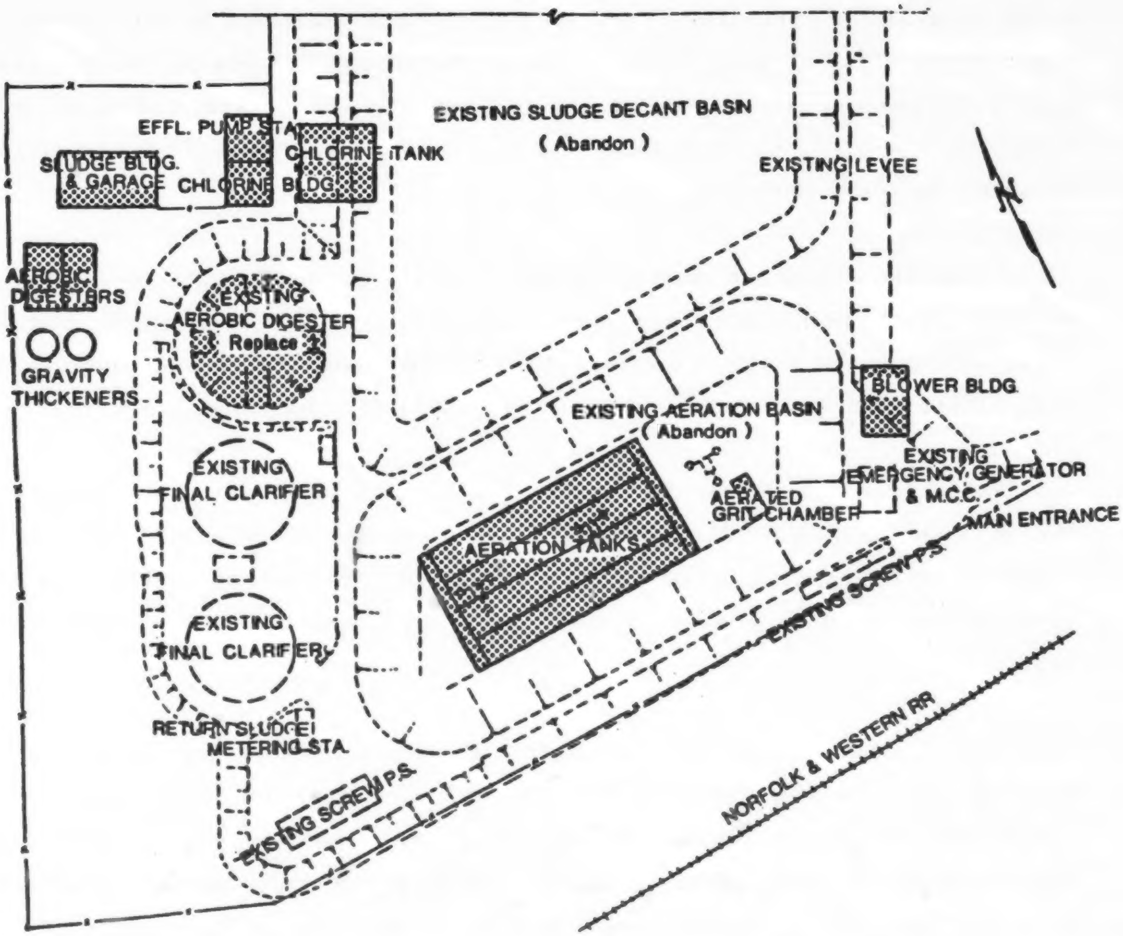

EXISTING SLUDGE DECANT BASIN
(Abandon)
EFFL. PUMP STA.
CHLORINE TANK
SLUDGE BLDG.
& GARAGE
CHLORINE BLDG.
EXISTING LEVEE
N
AEROBIC DIGESTERS
EXISTING
AEROBIC DIGESTER
Replace
GRAVITY THICKENERS
BLOWER BLDG.
EXISTING AERATION BASIN
(Abandon)
EXISTING
EMERGENCY GENERATOR
& M.C.C.
AERATED
GRIT CHAMBER
MAIN ENTRANCE
EXISTING
FINAL CLARIFIER
AERATION TANKS
EXISTING SCREW P.S.
EXISTING
FINAL CLARIFIER
RETURN SLUDGE
METERING STA.
EXISTING SCREW P.S.
NORFOLK & WESTERN RR

Figure 2-18. Spencer Creek STP proposed schematic.

or development in the area could be hindered. A 0.5-mgd contact stabilization plant was proposed in the facilities plan and would provide enough capacity to meet the interim demands. Due to the temporary nature of this plant, nitrification is not proposed.

The combined flow capacity of the Harvester-Dardenne and Duckett Creek plants is 2.0 mgd. As of July 1984, the Harvester-Dardenne and Duckett Creek plants were receiving 1.4 mgd and 0.6 mgd, respectively, for a total of 2.0 mgd. Once the Harvester-Dardenne pump station is completed, part of the excess flow (i.e., flow exceeding 1.0 mgd) could be diverted to the Duckett Creek Plant, so that both plants would initially be operating at capacity. Since this would allow no excess capacity to handle growth during construction of the new Duckett Creek Plant (scheduled for completion in 1988), an additional package plant is proposed. It was determined in the final facilities plan that a 1.0-mgd contact stabilization plant would provide sufficient capacity to meet the interim demands.

Portage des Sioux Plant

The Portage des Sioux STP would be upgraded to a secondary facility. However, it is recommended that an extended aeration package plant be constructed in lieu of the 1978 selection of a rotating biological contactor plant.

2.3.4.3 Onsite Systems

There are three general classifications of existing onsite system areas: (1) developments along the Mississippi River and in the floodplain that are serviced by individual shallow wells and onsite systems; (2) the upland portion of the planning area; and (3) residences in areas with karst topographic features, mainly around Taylor Branch. The final facilities plan concludes that the use of onsite systems in densely populated areas in the upland portions of the planning area (area 2), and developments in karst topography (area 3), should be discontinued as interceptors are constructed.

Although the residences currently served by onsite systems in the Mississippi River floodplain (area 1) were originally recommended (in the draft facilities plan) to be served by centralized collection and treatment facilities where the density of residences was sufficient, it has subsequently been determined (by the facilities planner) that these floodplain communities cannot afford the cost of collection and transmission systems for treatment of sewage at the nearest centralized facility. As such, a centralized collection system for the major floodplain communities was not considered implementable. Instead, a plan was proposed that could mitigate problems without being capital-intensive. The proposed plan would include the following measures:

- Establishment of a centralized management agency that would institute programs for upgrading and maintaining onsite systems;
- A public education program on proper septic tank and absorption field operation;
- Emphasis on the need for community wells to replace individual shallow wells;
- Clustering homes to small onsite systems;
- Holding tanks for riverfront properties; and
- Flow conservation practices and devices to reduce the load on existing onsite systems.

This EIS concurs with these recommendations for the unsewered areas based on several factors:

- Approximately 50% of the residences are occupied seasonally;
- The groundwater contamination potential is limited because the permeability of the soils is low;
- Contamination of shallow wells, specifically from failing onsite systems, was not demonstrated and, in fact, evidence indicates deficient well construction and floodwater contamination as being the problems rather than onsite systems (by telephone, Roger Dunacik, St. Charles County Health Department, to WAPORA, Inc. 19 April 1984);
- The investment in infrastructure in areas that flood frequently should be kept to a minimum so that the residences can be phased out; and
- The onsite system wastewater management option would likely be less costly than the centralized option for the floodplain areas, although the cost comparisions were not developed in the facilities plan.

The continued use of some onsite systems in the upland areas also would be necessary for numerous residences because interceptor sewers are not and will not be located sufficiently close to provide service. Sufficient data have not been presented in the facilities plan to ascertain whether or not continued use of onsite systems in these areas would be technically feasible if centralized management and systematic upgrading of failing systems were to be implemented. Regardless of the final wastewater management options selected for the respective "problem areas," implementation of an onsite management district would be required for those residences that would not be served by centralized alternatives.

2.3.4.4 Private Systems

Two wastewater treatment facilities, the Tee Kay lagoon and the Martell lagoon, serve isolated communities in the South Plant service area. Interceptors are not yet available due to cost related to low population density. As the population grows, interceptors would be extended to these outlying areas and the facilities plan recommends that these lagoons should be eliminated. Meanwhile, strict enforcement of NPDES permits should reduce the impact that these lagoons may have on water quality in the planning area.

2.3.4.5 Small Systems Outside the Planning Area

The draft facilities plan indicates that pollution to upper Dardenne Creek by small treatment plants located just outside of the planning area could be reduced by strict enforcement of NPDES permits conditions. The Weldon Spring Elementary School and Safari Campground each have treatment plants that may affect Dardenne Creek water quality. Eventually, these areas should be eliminated as interceptors are constructed.

2.3.4.6 Summary of Costs

Construction cost and operation and maintenance cost estimates for the selected wastewater collection systems and treatment facilities are presented in Tables 2-14 and 2-15, respectively. Costs are provided for both the 1985 and 2005 design years. The 1985 costs include those facilities that are necessary to handle existing sewage flows. The 2005 costs include capacity to support the population growth during the 20-year planning period. The 1985 design costs determine the amount of the project costs that are grant eligible. This is discussed in more detail in the following section. For Portage

TABLE 2-14

FACILITY PLAN RECOMMENDED ALTERNATIVE CONSTRUCTION COST ESTIMATES
(June 1984 Costs)

A. DUCKETT CREEK	2005 Design	1985 Design
(1) Duckett Creek Plant	$ 9,899,000	$ 8,082,000
(2) Interim South Plant (Package Plant)	520,000	520,000
(3) Boschertown Interceptor	385,000	374,000
(4) South Interceptor	2,157,000	1,968,000
(5) Harvester-Dardenne Interceptor	1,020,000	854,000
(6) Interim Duckett Creek Plant (Package Plant)	800,000	800,000
TOTAL ESTIMATED CONSTRUCTION COST:	$14,781,000	$12,598,000

B. ST. CHARLES	2005 Design	1985 Design
(1) Missouri River Plant	$ 7,039,000	$ 5,811,000
(2) Mississippi River Plant	2,899,000	1,034,000
(3) Missouri River Interceptor	1,616,000	1,511,000
TOTAL ESTIMATED CONSTRUCTION COST:	$11,554,000	$ 8,356,000

C. ST. PETERS	2005 Design	1985 Design
(1) Spencer Creek Plant	$ 4,595,000	$ 1,535,000
(2) Effluent Pipe (Force Main)	2,371,000	1,858,000
TOTAL ESTIMATED CONSTRUCTION COSTS:	$ 6,966,000	$ 3,393,000

D. PORTAGE DES SIOUX	2005 & 1985 Design
(1) Portage des Sioux Plant	$ 511,400
(2) Portage des Sioux Transmission System	214,700
(3) North Area Transmission System	146,300
(4) Northeast Area Transmission System	141,400
TOTAL ESTIMATED CONSTRUCTION COST:	$1,013,800

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1984)

TABLE 2-15

FACILITY PLAN RECOMMENDED ALTERNATIVE
ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATES
(June 1984 Costs)

A. DUCKETT CREEK	2005 Design
(1) Duckett Creek Plant	$ 394,000
(2) Interim South Plant	80,000
(3) Interim Duckett Creek Plant	115,000
(4) Transmission System (1, 2, & 3)	203,000
(5) Remaining Facilities (4)	86,000
(6) Administrative	183,000
TOTAL ESTIMATED ANNUAL O&M COST:	$ 866,000 (5a)
B. ST. CHARLES	
(1) Mississippi River Plant	$ 585,000
(2) Missouri River Plant	359,000
(3) Transmission System (5b)	8,000
(4) Remaining Facilities (6)	99,000
(5) Administration	329,000
TOTAL ESTIMATED ANNUAL O&M COST:	$1,380,000
C. ST. PETERS	
(1) Spencer Creek Plant	$ 353,000
(2) Transmission System (7)	2,000
(3) Remaining Facilities (8)	113,000
(4) Administration	117,000
TOTAL ESTIMATED ANNUAL O&M COST	$ 585,000

Table 2-15 (concluded).

D. PORTAGE DES SIOUX	2005 Design
(1) Portage des Sioux Plant	$ 25,800
(2) Transmission System	6,600
TOTAL ESTIMATED ANNUAL O&M COST:	$ 32,400

Notes:

1. Includes Harvester-Dardenne, South, and Dardenne pump stations
2. Includes Harvester-Dardenne and Dardenne pump station force mains
3. Includes South interceptor
4. Includes existing sewers and pump stations
5a. Assumes Interim South and Duckett Creek Plants are eliminated
5b. Includes Missouri River Interceptor (Phase III)
6. Includes building maintenance, existing sewers, and pump stations
7. Includes Spencer Creek Plant effluent line to the Mississippi River
8. Includes existing sewers and pump stations

Source: Adapted from Sverdrup & Parcel and Associates, Inc. (1984)

des Sioux and the Mississippi floodplain, sewage flows are not anticipated to be significantly different in the future, so the 1985 and 2005 costs are the same. The total estimated 2005 construction cost for the facilities plan recommended alternative (Alternative 6) was $34,314,800, while the total estimated annual (2005) operation and maintenance cost was $2,863,400 in June 1984 dollars.

2.3.4.7 Financing Requirements and Arrangements

The Duckett Creek Sewer District, City of St. Charles, City of St. Peters, and the City of Portage des Sioux each have the legal authority and financial resources to construct, operate, and maintain the proposed facilities for their respective systems, if approved and adequately funded by the responsible state and Federal agencies.

Communities in the Mississippi River floodplain must become part of a sewer district, incorporate, or have a legal authority such as a management agency act on their behalf to be eligible for construction grants. It is recommended that one of the existing sewer agencies or the St. Charles County Regional Sewer District become the management agency for the floodplain communities, including Peruque, Kampville, and South Shore. Each local agency would be responsible for grant applications and administration of the design and construction of improvements under the EPA Construction Grants Program or State Grant Program. Each would also be responsible for the operation and maintenance of its system.

Federal and State Aid

Construction costs for the various wastewater facilities were estimated in Table 2-16. There are other costs, however, that must be included for a total project cost estimate. These other costs include engineering and technical services, legal fees, project administration, land acquisition, and interest during construction. These costs also are summarized in Table 2-16.

The proposed construction projects in the Duckett Creek facilities planning area are eligible for Federal construction grants assistance. The grant eligible items include pumping stations, interceptor sewers, force mains, treatment units, and sludge disposal facilities. After 30 September 1984, these items qualify for 55% Federal funding for conventional projects. Projects using innovative and alternative technology are eligible for an addi-

TABLE 2-16

CALCULATION OF LOCAL SHARE OF COSTS
(June 1984 Costs)

Description	Grant Eligible Conventional Treatment	Not Grant Eligible	Total
• DUCKETT CREEK SEWER DISTRICT, 2005 Design			
Transmission System	$ 3,196,000	$ 366,000	$ 3,562,000
Treatment System	9,402,000	1,817,000	11,219,000
Construction Total	$12,598,000	$2,183,000	$14,781,000
Engineering Design	601,000	293,000	894,000
Other Engineering*	1,323,000	229,000	1,552,000
Interest During Construction		601,000	601,000
Legal Services, Administrative		168,000	168,000
Land Acquisition		30,000	30,000
Subtotal	$14,522,000	$3,504,000	$18,026,000
Federal Share	7,987,000	--	7,987,000
State Share	3,630,000	--	3,630,000
Local Share	$ 2,905,000	$3,504,000	$ 6,409,000
• CITY OF ST. CHARLES, 2005 Design			
Transmission System	$ 1,511,000	$ 105,000	$ 1,616,000
Treatment System	6,845,000	3,093,000	9,938,000
Construction Total	$ 8,356,000	$3,198,000	$11,554,000
Engineering Design	419,000	349,000	768,000
Other Engineering*	877,000	336,000	1,213,000
Interest During Construction		708,000	708,000
Legal Services, Administrative		174,000	174,000
Land Acquisition			
Subtotal	$ 9,652,000	$4,765,000	$14,417,000
Federal Share	5,309,000	--	5,309,000
State Share	2,413,000	--	2,413,000
Local Share	$ 1,930,000	$4,765,000	$ 6,695,000

Table 2-16 (continued)

Description	Grant Eligible Conventional Treatment	Not Grant Eligible	Total
• CITY OF ST. PETERS, 2005 Design			
Transmission System	$ 1,858,000	$ 513,000	$ 2,371,000
Treatment System	1,535,000	3,060,000	4,595,000
Construction Total	$ 3,393,000	$3,573,000	$ 6,966,000
Engineering Design	190,000	349,000	539,000
Other Engineering*	356,000	375,000	731,000
Interest During Construction		423,000	423,000
Legal Services, Administrative		153,000	153,000
Land Acquisition		48,000	48,000
Subtotal	$ 3,939,000	$4,921,000	$ 8,860,000
Federal Share	2,166,000	--	2,166,000
State Share	985,000	--	985,000
Local Share	$ 788,000	$4,921,000	$ 5,709,000

Description	Grant Eligible Conventional Treatment	Grant Eligible Innovative/ Alternative Technology*	Not Grant Eligible	Total
• CITY OF PORTAGE DES SIOUX, 2005 Design				
Transmission System	$ 214,700	$ 146,300	$141,400	$ 502,400
Treatment System	511,400			511,400
Construction Total	$ 726,100	$ 146,300	$141,400	$1,013,800
Engineering Design	47,800	9,600	21,200	78,600
Other Engineering*	76,200	15,400	14,800	106,400
Interest During Construction			15,000	15,000
Legal Services, Administrative			10,900	10,900
Land Acquisition			15,000	15,000
Subtotal	$ 850,100	$ 171,300	$218,300	$1,239,700
Federal Share	467,600	128,500	--	596,100
State Share	212,500	25,700	--	238,200
Local Share	$ 170,000	$ 17,100	$218,300	$ 405,400

* Includes land and field surveys, construction inspection and management, O&M manuals, training, and start-up.

Source: Sverdrup & Parcel and Associates, Inc. (1984)

tional 20% Federal share, or a total of 75% Federal funding. It is anticipated that all items listed in Table 2-16 are grant-eligible, except for land acquisition, legal and administrative costs, and interest during construction. Grant eligibility is limited to the capacity needed to serve the existing development at the time of Step 3 construction grant approval.

The Missouri Clean Water Commission has a program to provide additional construction grant funds equal to a 25% share after 30 September 1984. For innovative and alternative projects, the State grant share after 30 September 1984 is 15%. These funds apply to the same eligible items as the Federal grant. In addition, the Missouri Clean Water Commission administers a new State construction grant program where Federal funding is not involved. This program allows the State to make 55% grants to communities for wastewater facilities. The grant amount is limited to $500,000 per year for communities with a service area of less than 500,000 persons.

The amount of Federal and state monies available to fund the construction grants program is quite limited relative to the number of projects for which assistance is sought. To ensure that the available money is spent on the most serious water quality problems, the State of Missouri maintains a priority list which ranks the projects seeking funding on a variety of factors, including water quality problems, population affected, public health hazards, and others. Because of the many projects throughout the state attempting to obtain Federal and state funding, and the reduced levels of funding currently available, some of the projects recommended for implementation in the Duckett Creek Facility Planning Area may not be able to obtain Federal or state grant assistance.

Local Share of Costs

There are three basic bonding methods to finance the local share of capital improvements: (1) general obligation bonds, (2) revenue bonds, and (3) special assessment bonds. Each has advantages and disadvantages.

- General Obligation Bonds -- A general obligation bond is backed by the full faith and credit of issuer. Generally, this type of bond is supported by an advalorem tax on real property and must be approved by referendum prior to issuance. Because of the security provided by the pledge of a community, they usually have a lower interest rate than other types of bonds and are more readily sold. Also, overhead costs of financing, including engineering, legal, and financial, are less for general obligation bonds than for revenue bonds, where detailed engineering reports and surveys, complex legal agreements, and financial analyses are likely to be required. The total amount of general obligation bonds that can be issued is limited by a percentage of the total assessed valuation of the issuer's taxable property. The percentage varies depending on whether the authority is a county, city, town, or village. Bonding capacities can sometimes be increased for specific projects, such as wastewater treatment improvements, when approved by the votors and state agencies. General obligation bonds generally are required to mature within the estimated useful life of the improvements to be financed. Issuers are usually prevented from deferring repayment of the principal for future generations, although this may be justified in some cases by expected future revenue from growth. One major drawback of general obligation bonds is that the Hancock Amendment prevents any future increase in user charges (which may be required if revenues fall short of costs) without voter approval. This feature tends to reduce the popularity of general obligation bonds and enhance the attractiveness of revenue bonds.

- Revenue Bonds -- Revenue bonds are backed by charges for services provided. They do not normally depend on money derived from taxes or special assessments. The net revenue from operating the wastewater treatment plant must meet the obligations of the bond issue. There is usually no further backing of revenue bonds. There are no legal limitations on the amount of revenue bonds that may be issued, but excessive offerings represent high investment risks and are unattractive to bond buyers. In rating revenue bonds, the buyers look at the justification of the project, reputation of the borrower, rate structures, methods of billing and collecting, provisions for rate increases if necessary, adequacy of reserve funds, legal protection of project revenues, and the overall soundness and conservatism of the revenue forecast. One key advantage of revenue bonds is that they can be used to finance projects extending beyond municipal boundaries. They may be supported by a pledge of revenues from any legitimate area of operation, whether within the geographical limits of the borrower or not. Also, revenue bonds are exempt from any restrictions imposed by the Hancock Amendment. Many authorities and commissions have no available means of raising capital for major projects other than revenue bonds.

- Special Assessment Bonds -- A special assessment bond is payable from liens on the properties served, not from general tax revenues. Such bonds are issued only where certain properties are recipients of special benefits not accruing to other properties. The assessment is intended to fairly apportion the cost of the improvement among the affected property owners in accordance with the increased value of each parcel. If the assessment is not paid, a lien is placed on the assessed property. Special assessment bonds are sometimes used to finance sewers. Here, the benefits to properties are direct and obvious. Front-footage and area are two measures of benefit used for assessing properties. The authority to issue special assessment bonds is granted in most states to municipalities, special purpose districts, commissions, and other public bodies. Provisions for enforcing collections, the status of the lien relative to other liens, and penalty provisions for unpaid assessments which can be used to build up a reserve fund, are important aspects in the interest rate established for the special assessment bond. Like revenue bonds, special assessment bonds are exempt from any restrictions imposed by the Hancock Amendment.

- Private Financing -- An alternative to traditional public works funding through bonds is private financing. Private financing provides alternatives for communities that cannot obtain grant funding or that experience difficulty in issuing bonds. The attraction for this private developer is the potential Federal tax benefits accruing from depreciation, investment tax credits, and the use of industrial bonds. There are at least three alternatives for sewer agencies that are unable to generate public support for new taxes or have stretched their borrowing power to its limits: (1) normal leasing--the sewer agency avoids long-term capital debt by renting a facility from a private developer; (2) lease-purchase--rent payments over a fixed period eventually give the sewer agency title to a facility built and financed by a private developer; and (3) service contracting--under a contract, a developer provides and operates a facility, eliminating the need for capital funding by the sewer agency and also shifting tha administrative burden of operations. One drawback of private financing is that the construction projects are not eligible for Federal or state grants. Also, it may be necessary to pay back previously awarded grants, should ownership of a facility constructed under the construction grants program be given to a private party.

- Other Revenue Sources -- Annual revenue required to offset the costs of managing, operating, and maintaining the system, and to retire debts is obtained from various sources. Taxes, service charges, and connection fees are the main methods used. A requirement for Federally funded projects is that the user charge system be approved for compliance with EPA user charge regulations. Property and real estate taxes are commonly used by large and small communities; however, ad valorem taxes must have been specifically dedicated prior to 27 December 1977 and must still reflect proportionate use of the wastewater system. Revenues may be from a specified tax levy or may be budgeted from a general fund. When revenue is exclusively derived from taxes, accounting and billing work is minimal, and there is no need to measure flows or to sample wastewater for charge purposes. One major objection to a real estate and personal property taxation system is that the users do not pay in proportion to their use or benefits received. An industry may have a high sewer tax, but produce little or no industrial wastewater. In many areas, particularly those with diverse types of customers, wastewater service charges are a primary or supplemental method of raising revenue. Wastewater service charges are usually based on a cost apportionment system that correlates service charges with the actual physical use of the treatment system. Often, rates are established using one or more of the following criteria:

  -- Volume of wastewater
  -- Amount of excess pollution loadings, including suspended solids and BOD
  -- Type of property, such as residential, commercial, or manufacturing
  -- Number and type of plumbing fixtures or rooms

A deficiency of service charges is that they do not provide for payment on undeveloped properties or for the benefit of having sewage treatment capacity available, whether used or not. The concurrent use of taxes and service charges may be the most equitable for all parties.

Connection charges can be used to supplement revenues. A one-time initial charge at the time a new user connects to the sewer system can be a small fee to cover the expense of an in-inspection or can be significant to offset capital costs. The connection fee is often based on front-footage or area and type and size of connection. The amount charged may have an effect on sewer expansion and new development.

Consumer Cost

An acceptable user charge system to determine the service charges to consumers for support of the wastewater treatment facilities will be developed during the final design stage. Service charges ideally should be structured so each user pays the cost of operating the wastewater treatment and disposal system in proportion to its wastewater contribution, but this is not required by EPA regulations.

January 1984 user charges for residential customers of the three major sewer agencies are as follows:

Agency	Rate	Estimated Annual User Charge*
Duckett Creek	$23.55/quarter	$94
St. Charles	$ 2.00/month + $0.85/1,000 gal.	$94
St. Peters	$ 1.66/bimonthly + $0.96/1,000 gal.	$89

Future costs are dependent upon the amount of improvements necessary for adequate wastewater treatment and the population growth of each service area.

Preliminary calculations for user charges are presented in Table 2-17 for each sewer agency. User charges are calculated for design years 1985 and 2005. Calculations for 1985 include debt service for only those projects underway during 1985. Calculations for 2005 include all projects. Annual debt service pays the local capital cost of improvements and is based on an annual interest rate of 10% for a 20-year payment period. Annual O&M costs

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* Based on water meter readings equivalent to three persons per household at 75 gallons per capita per day, 365 days per year.

TABLE 2-17
PRELIMINARY CALCULATION OF USER CHARGES
(June 1984 Costs)

- DUCKETT CREEK SEWER DISTRICT

	1985	2005
Local share of capital cost	$6,409,000	$6,409,000
Annual debt service (1)	151,000	753,000
Annual O&M cost (2)	1,140,000	1,460,000
Total annual cost	$1,291,000	$2,213,000
Projected users	10,800	19,000
ANNUAL USER CHARGE	$120	$116

- CITY OF ST. CHARLES

Local share of capital cost	$3,869,000	$6,695,000
Annual debt service (1)	91,000	787,000
Annual O&M cost (2)	1,665,000	1,605,000
Total annual cost	$1,756,000	$2,392,000
Projected users	18,300	29,900
ANNUAL USER CHARGE	$96	$80

- CITY OF ST. PETERS

Local share of capital cost	$5,709,000	$5,709,000
Annual debt service (1)	134,000	671,000
Annual O&M cost (2)	340,000	616,000
Total annual cost	$ 474,000	$1,287,000
Projected users	9,400	16,200
ANNUAL USER CHARGE	$50	$79

Table 2-17 (concluded).

- CITY OF PORTAGE DES SIOUX

	1985	2005
Local share of capital cost	$ 405,400	$ 405,400
Annual debt service (1)	23,800	47,600
Annual O&M cost (2)	32,400	32,400
Total annual cost	$ 56,200	$ 80,000
Projected users	200	230
ANNUAL USER CHARGE	$281 (3)	$348 (3)

---

(1) Based on a 10% annual interest rate and a 20-year payment period capital recovery factor = 0.1175). Assumes 20% of the bonds are issued during 1985.

(2) Includes O&M, debt service, and other costs of the existing system and O&M of proposed improvements.

(3) Assumes that 50% of the bonds are issued in 1985. Annual user charges, if North Area and Northeast Area Transmission System projects are not constructed, are estimated at $242/yr for 1985 and $266/yr for 2005.

Source: Sverdrup & Parcel and Associates, Inc. (1984)

include the cost to run the existing and proposed facilities as well as existing debt service. The annual user charge is calculated by dividing the total annual cost by the projected number of users. Costs are in June 1984 dollars.

The annual user charges that are presented are preliminary values. Various methods of financing are available, as discussed previously and additional charges for items such as bond coverage are not included. Additional receipts such as from industrial contributors, connection fees, special fees, or taxes can be used to offset capital costs, thus lowering the annual debt service, which, in turn, lowers the annual user charge. Numerous financing alternatives are possible for each sewer agency and the number of different combinations would make them difficult to present. For this reason, the approach was taken to identify the major components in the user charge determination and to present a preliminary baseline annual user charge for each agency to adjust according to its particular financing capabilities or other needs.

2.4 Alternatives Available to EPA

Two basic alternatives are available to EPA through the MDNR: (1) awarding of a construction grant to the Duckett Creek Sewer District, and (2) denial of a grant. Grant denial constitutes the no action alternative for EPA. Prior to 1 October 1984, a grant could amount up to 75% of the eligible cost of constructing conventional treatment facilities, and up to 85% of the eligible cost of constructing innovative/alternative technology facilities. However, after October 1984, any funding would be limited to 55% of the eligible portion of the cost of constructing conventional treatment facilities and 75% of the eligible portion of the cost of constructing innovative/alternative technology facilities.

2.5 Alternatives Available To Other Agencies

The Missouri Department of Natural Resources (MDNR) also has two funding alternatives: (1) awarding of a construction grant to the Duckett Creek Sewer District, and (2) denial of a grant. In addition, the US Army Corps of Engineers can issue or deny a Section 404 and/or a Section 10 permit for those project activities that would require a USCOE permit prior to construction.

3.0 AFFECTED ENVIRONMENT

The planning area is located in eastern St. Charles County, Missouri and encompasses the lower Dardenne, Spencer, and Duckett Creek watersheds. The planning area includes the City of St. Charles, the City of St. Peters, and the Duckett Creek Sewer District. The planning area is situated between the Missouri and Mississippi rivers immediately west of the confluence of the two rivers. A broad floodplain area exists in a northern portion of the planning area and contains agricultural uses, scattered residential and industrial development, and extensive waterfowl habitat in low-lying wetlands, sloughs and oxbows. The floodplain area is not served by centralized wastewater collection and treatment systems. The majority of the population in the planning area is in the upland portion which is characterized by rolling hills and rounded divides. Wastewater collection and treatment primarily is provided by the three participating entities and, in some areas, by private utility districts that serve a single subdivision. This section of the EIS has been prepared to document existing environmental conditions for the subsequent evaluation of environmental impacts associated with the project alternatives.

3.1 Natural Environment

3.1.1 Atmosphere

3.1.1.1 Climate

The planning area has a "modified continental climate... without the undue hardships of prolonged periods of extreme heat or high humidity" (National Oceanic and Atmospheric Administration [NOAA] 1979). A variety of weather conditions prevail, influenced by warm, moist air from the Gulf of Mexico, and cold, dry air from Canada.

Temperatures in the planning area are relatively mild throughout the year with an average monthly temperature of 55.9°F (Appendix A). Temperatures above 90°F occur 35 to 40 days per year, and temperatures below 0°F occur only 2 or 3 days per year (NOAA 1979).

Average annual precipitation amounts to 35.9 inches (Appendix A). December, January, and February are the driest months with less than 6 inches of precipitation. Approximately 44% (15.9 inches) of the average annual precipitation occurs from April through June. Precipitation between July and November is intermittent. Periods of 1 to 2 weeks without significant amounts of precipitation are not unusual (NOAA 1979). High 24-hour precipitation levels associated with thunderstorm activity occur on a periodic basis from April through October. Most of the major floods in the St. Louis area are caused by heavy precipitation in the spring. However, some of the highest floods on record have been caused by intense local thunderstorms during the summer that result in flash-flood conditions on small tributary streams, with subsequent effects on the larger streams (Miller et. al 1974; Section 3.1.3.3.).

Winters are relatively mild. Over the past 50 years, annual snowfall has averaged less than 20 inches (NOAA 1979). Snowfalls of 1 inch or more usually occur from 5 to 10 days each year. Snow has fallen as early as 5 November and as late as 2 May (NOAA 1979).

Southerly winds predominate 7 months out of the year, from May through November (NOAA 1979). The average wind speed is 8.6 miles per hour (mph). Winds during the winter months are predominantly from the northwest and west-northwest. Wind speeds are higher during the winter months, averaging 10.9 mph.

3.1.1.2. Air Quality

St. Charles County is located within the metropolitan St. Louis Interstate Air Quality Control Region. Federal air quality standards, as set forth in the Clean Air Act of 1970, must be maintained. The National Primary Ambient Air Quality Standards (NAAQS) for the major pollutants affecting the planning area are presented in Table 3-1.

Carbon monoxide (CO) is the most pervasive air pollutant and is formed when carbon-containing fuel is not burned completely. More than 75% of the CO emitted in the St. Louis metropolitan area comes from motor vehicles. The area bordered by I-270 and the Mississippi River has been designated a nonattainment area for CO. However, CO levels above the 8-hour standard in the nonattainment area declined from 32 occurrences in 1978 to 5 occurrences in

Table 3-1. National primary ambient air quality standards (40 CFR 50).

Averaging Time	Pollutant[a] CO	SO2	TSP	NO_2	O_3
Annual Arithmetic Mean	--	80	--	100	--
Annual Geometric Mean	--	--	75	--	--
1-Hour	40	--	--	--	235
8-Hour	10	--	--	--	--
24-Hour	--	365	260	--	--

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[a] CO-carbon monoxide
SO_2-sulfur dioxide
TSP-total suspended particulates
NO_2-nitrogen dioxide
O_3-ozone
CO is measured in milligrams per cubic meter (mg/m^3); all other pollutants are measured in micrograms per cubic meter (ug/m^3).

1981 (MDNR 1982). There are no CO monitoring stations in the planning area. The nearest monitoring station for CO is on St. Charles Rock Road just east of Lindbergh Road in St. Ann. The 1-hour standard for CO (40 mg/m^3) was only exceeded once at this station during the past 5 years; however, the 8-hour standard (10 mg/m^3) was exceeded 5 times in 1981. Although these instances of high CO concentrations indicate a continuing CO problem, a trend toward improvement also is apparent. In 1977 and 1978, the 8-hour CO standard was exceeded 12 and 10 times, respectively, at the St. Ann station (MDNR 1982).

Sulfur oxides are produced from the burning of fuels containing sulfur, primarily coal and oil, and also from the smelting of metals and from some industrial processes. The St. Louis metropolitan area is an attainment area for sulfur dioxide (SO_2) which comprises approximately 95% of the sulfur oxide gases. There is a SO_2 monitoring station within the planning area at Weldon Spring. There has not been a discernible trend in SO_2 concentrations at this station in the past 5 years. The highest arithmetic mean recorded at this station in the past 5 years was in 1980 (28 ug/m^3), but the 1981 arithmetic mean (18 ug/m^3) was consistent with the lower concentrations recorded in 1977 and 1978 (12 and 15 ug/m^3, respectively). The 24-hour primary standard (365 ug/m^3) has not been exceeded at this station during the past 5 years.

Particulates are the solid and liquid materials suspended in the atmosphere. They include dust, soot, and fly ash. Coal combustion, construction activities, traffic on unpaved roads and parking lots, agricultural activities, emissions from oil refineries, lead smelters, cement plants, aluminum reduction plants and asphalt batch plants, and automobile exhausts are all sources of particulates. The entire City of St. Louis has not attained the secondary standard for total suspended particulates (TSP) and the downtown area of the City has not attained the primary standard (MDNR 1982). There is a TSP monitoring station adjacent to the planning area in West Alton. Since 1978, TSP concentrations at this station have been very consistent, ranging between 59 and 61 ug/m^3. The secondary standard (150 ug/m^3) has been exceeded once each year since 1978, with the exception of 1980 (no data are available for 1981; MDNR 1982).

Nitrogen dioxide is formed when fuel is burned at very high temperatures (above 650°C). The principal sources of nitrogen dioxide emissions are power plants and industrial boilers, and auto and truck engines. According to the MDNR (1982) "...there are no high concentrations of nitrogen dioxide in Missouri."

Ozone in the lower atmosphere is the major component of photochemical smog. It is formed by a series of chemical reactions that occur when reactive hydrocarbons and nitrogen oxides are exposed to sunlight. All of the St. Louis metropolitan area, including the planning area, is a nonattainment area for ozone. The ozone monitoring station nearest to the planning area is in West Alton. Although the arithmetic mean for ozone at this station (50 ug/m^3) was higher in 1981 than in the preceding 4 years, the primary standard (235 ug/m^3) was only exceeded on 3 days in 1981, as compared to 9 days during 1980 (MDNR 1982).

3.1.2. Land

3.1.2.1. Geology

St. Charles County is characterized by several types of geologic history including Paleozoic deposition and erosion, the advance and retreat of Pleistocene glaciers, and deposition of alluvium from major river systems. The surficial geology of the region is composed of Paleozoic strata from Ordovician to Pennsylvanian ages, Pleistocene glacial deposits and windblown materials (loess), and recent alluvial deposits from the Mississippi River, Missouri River, and their tributaries.

Physiography and Topography

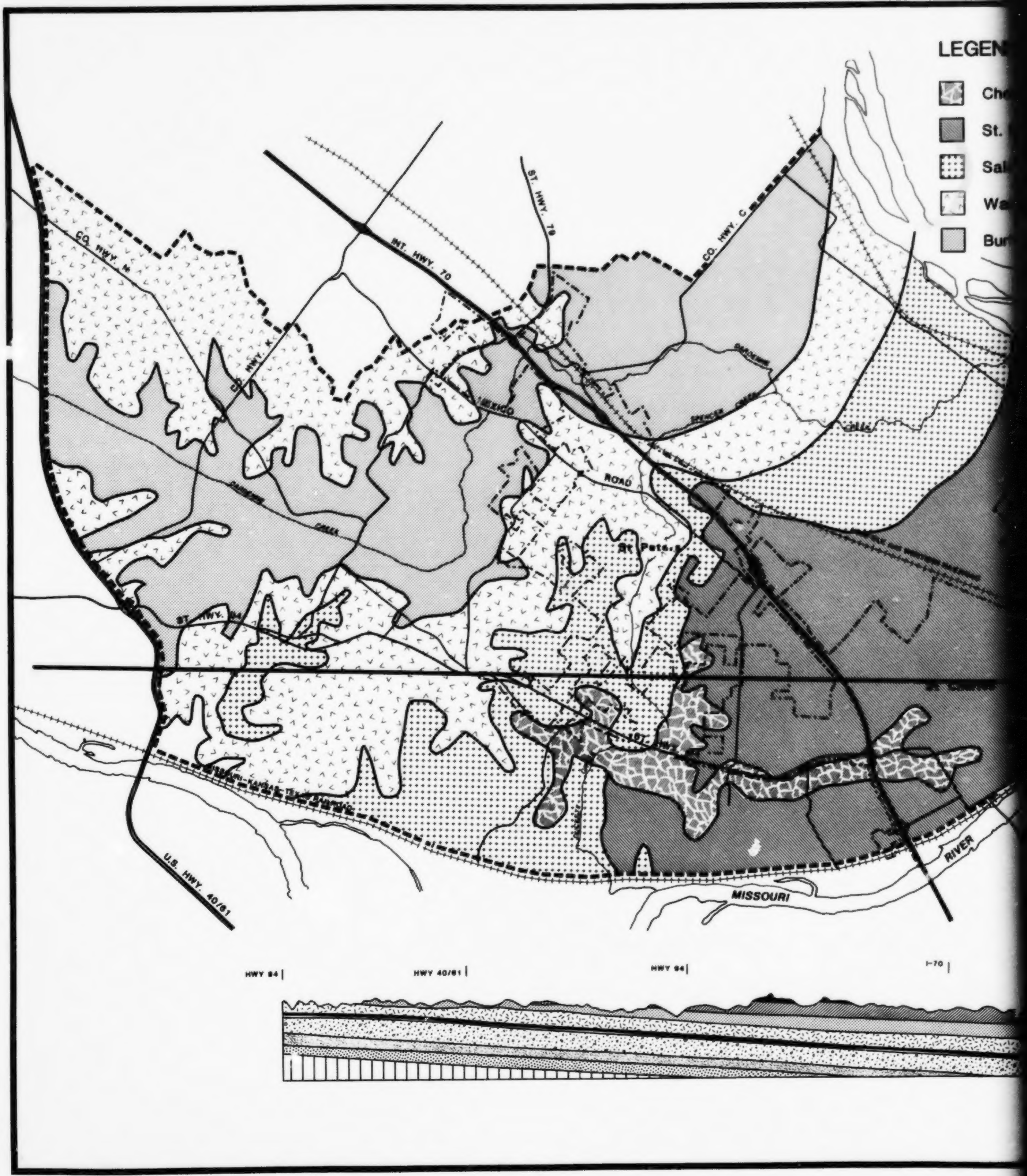
The planning area is located in the Dissected Till Plains section of the Central Lowland Physiographic province. Topographically, the planning area is divided into two different areas, an upland area and a floodplain area. Elevations in the planning area range from approximately 650 ft mean sea level (msl) in the extreme southwest to approximately 420 ft msl in the extreme northeast portion.

The upland area occurs north of the Missouri River floodplain and extends to approximately the Norfolk and Western Railroad line which roughly parallels Interstate 70 (I-70). This area contains hilly uplands with rolling to steep slopes and rounded divides. Slopes in the area are 10% or greater except in the stream valleys, and erosional gullies are present along drainage divides. An area of karst topography exists between Spencer Creek and Sandfort Creek near I-70 (karst topography is characterized by a rugged landscape with dissolution of the underlying limestone). A karst area also is present between Duckett Creek and Taylor Branch. Steep bluffs exist adjacent to the Missouri and Mississippi River floodplains.

Floodplain topography exists in the area adjacent to the Mississippi River, south to approximately the Norfolk and Western Railroad line. The land surface is nearly level to flat (slopes less than 5%).

Stratigraphy

The bedrock surface of the area (Figure 3-1) consists of Mississippian and Pennsylvanian aged sedimentary rocks under the uplands. Because the bedrock strata dip to the east, the bedrock surface under the floodplain alluvium consists of Mississippian age sedimentary rocks.



LEGEN
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SPENCER CREEK
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I-70

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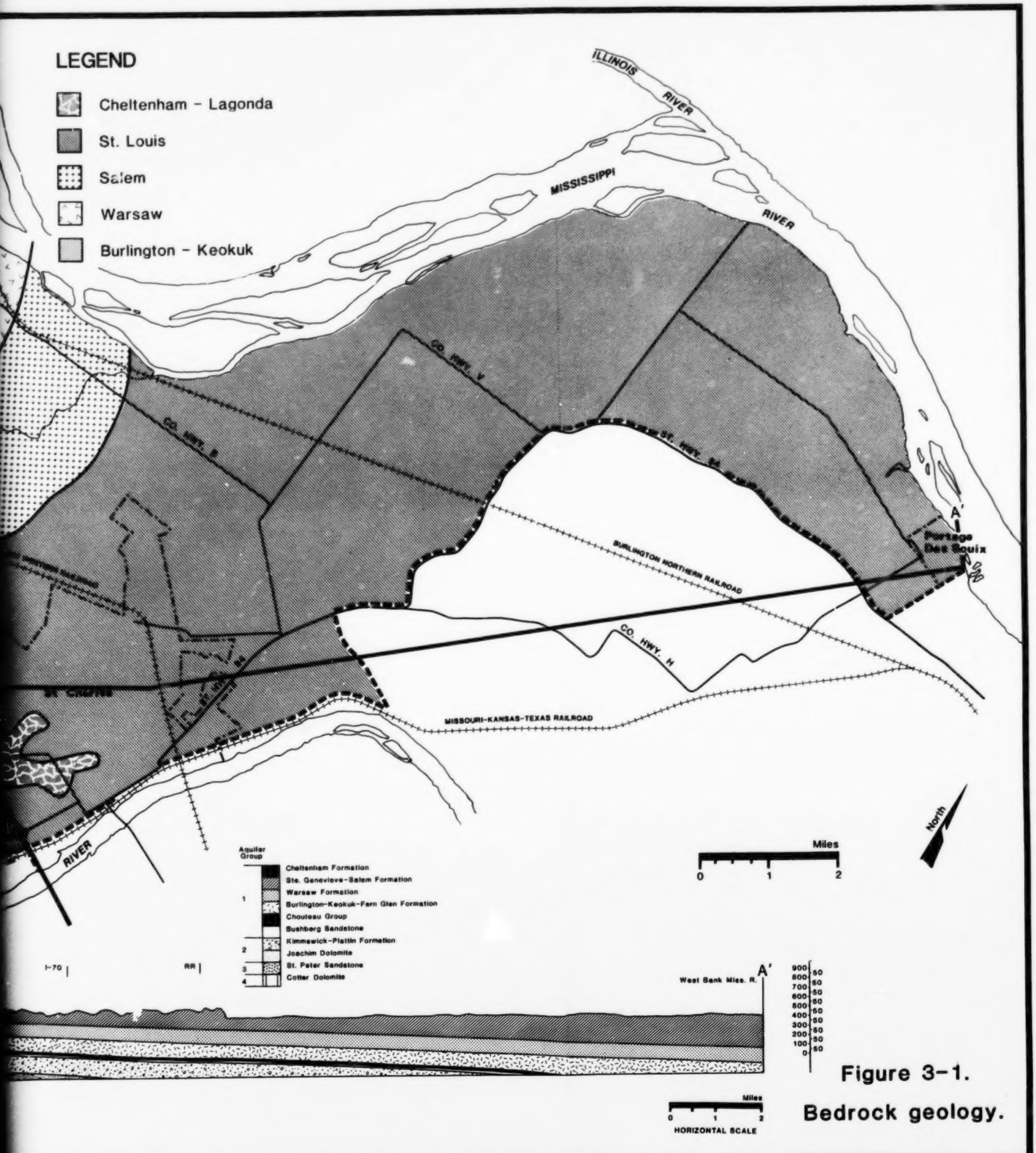

LEGEND
Cheltenham - Lagonda
St. Louis
Salem
Warsaw
Burlington - Keokuk
ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
A'
Portage Des Sioux
RIVER
North
Miles
0
1
2
Aquifer Group
Cheltenham Formation
Ste. Genevieve-Salem Formation
Warsaw Formation
Burlington-Keokuk-Fern Glen Formation
Chouteau Group
Bushberg Sandstone
Kimmswick-Plattin Formation
Joachim Dolomite
St. Peter Sandstone
Cotter Dolomite
1
2
3
4
I-70
RR
A'
West Bank Miss. R.
900
800
700
600
500
400
300
200
100
0
50
HORIZONTAL SCALE

Figure 3-1.
Bedrock geology.

Pleistocene and recent aged deposits overlie the bedrock except at some outcrops. In the upland areas, glacial till, loess, and occasional alluvium are present. In the floodplain, alluvium overlies the bedrock.

The formations that form the bedrock surface have been characterized by examination of outcrops. These are, from oldest to youngest:

- Burlington-Keokuk Formation - Of Mississippian age, this formation consists of interbedded limestone and chert. The limestone is gray, fossiliferous, medium crystalline. The chert is gray and buff containing bluish gray speckles, and the beds range in thickness from a few inches to a foot or more. Chert makes up from 25 to 75% of this formation. The Burlington-Keokuk Formation is exposed in the Dardenne Creek valley from the west end of the planning area to the Mississippi River.

- Warsaw Formation -- Of Mississippian age, this formation consists of shale and cherty limestone. The shale is usually buff to green, very calcareous to slightly dolomitic, and sometimes interbedded with thin shaly limestones. The bedded limestone are cherty, gray to yellowish gray, massive and sometimes dolomitic. The Warsaw Formation is exposed in the valley walls of Dardenne Creek.

- Salem-St. Louis-Ste. Genevieve Limestones -- These Mississippian limestone formations are undifferentiated in the planning area. They are gray, fine to medium crystalline, medium bedded to massive, and occur as oolitic limestone, dolomitic to cherty limestone and shaley limestone. The Salem-St. Louis-Ste. Genevieve Limestones occur over most of the upland areas, especially in the bluffs of the Mississippi and Missouri rivers.

- Pennsylvanian Undifferentiated -- The Pennsylvanian aged strata are undifferentiated cyclic deposits consisting of shale with interbedded, thin sandstone, siltstones, limestone, and coal. They occur near Taylor Branch and on ridges in the area of Taylor Branch and the community of Harvester.

- Pleistocene to Recent Deposits -- The unconsolidated surficial deposits in the planning area consist of glacial till, loess, and alluvium. The glacial deposits extend from the north to the south valley wall of Dardenne Creek, the approximate limit of glaciation in this area, and consist of pebbly clay, sands, and silt. Loess (windblown deposits) is present on ridges and usually overlies residual soils (derived from weathered bedrock). In the planning area, two loess layers have been identified, the Roxana Loess and the Peoria Loess. The Roxana is the lower layer and is a clay-rich loess. The Peoria is the upper layer and is a silt-rich loess. Both layers total approximately 3 feet in thickness.

The alluvium in the planning area is extensive and thick (total thicknesses are reported to average from 80 to 100 feet) and cover the entire Mississippi River and Missouri River floodplains. The floodplains are historically defined by the rock bluffs along the rivers and not the maximum limits of flooding. The alluvium consists of clay, silt, sand, and gravel.

The subsurface stratigraphy of St. Charles County (Table 3-2) consists of strata from the Precambrian to Mississippian periods. These formations lie beneath the strata that outcrop in the planning area. Some of these formations outcrop in portions of St. Charles County other than the planning area. They consist of limestone, dolomite, chert, shale, and sandstone, and the maximum thickness of all strata is approximately 1,200 ft.

Structural Geology

The oldest exposed rocks in the planning area outcrop in the valley of Dardenne Creek. The strata dip gently (1%) to the northeast at the rate of approximately 50 feet per mile due to the presence of the Eureka-House Springs Anticline which is located just to the southwest of the planning area. Jointing is prevalent in the bedrock and controls the drainage patterns of creeks in the planning area. Solution activity in limestone bedrock is reflected in the topography as sinkholes and joint-pattern depressions.

St. Charles County is located approximately 170 miles north of New Madrid, Missouri, the approximate epicenter of the severe 1811-1812 earthquake. The St. Genevieve Fault Zone, on which the earthquake was thought to have occurred, lies in the Mississippi Valley near St. Genevieve. Numerous earthquakes have been reported within a 50-mile radius, though none has been particularly severe. On the basis of historic earthquake events and known zones of weakness in the earth's crust, the planning area is considered to be within Zone 2 of the Seismic Risk Map (Algermissen 1969) in which moderate damage is likely to occur.

Mineral Resources

Mineral resources of St. Charles County include limestone, sand, gravel, clay, shale, and coal. Most of these are of insignificant economic value, however. Limestone and industrial sand are the only two with any economic

Table 3-2. Stratigraphic column (source: Missouri Geological Survey and Water Resources)

Aquifers most favorable as water sources are shaded

System	Series	Group	Formation	Aquifer group	Thickness (feet)	Dominant lithology	Water-bearing character
Quaternary	Holocene		**Alluvium[1]**		0-150	Sand, gravel, silt, and clay.	Some wells yield more than 2,000 gpm.
	Pleistocene		Loess		0-110	Silt	Essentially not water yielding
			Glacial till		0-55	Pebbly clay and silt.	
Pennsylvanian	Missourian	Pleasanton	Undifferentiated	1	0-75	Shales, siltstones, "dirty" sandstones, coal beds and thin limestone beds.	Generally yields very small quantities of water to wells. Yields range from 0-10 gpm.
		Marmaton	Undifferentiated		0-90		
	Desmoinesian	Cherokee	Undifferentiated		0-200		
	Atokan		Undifferentiated				
Mississippian	Meramecian		Ste. Genevieve Formation		0-160	Argillaceous to arenaceous limestone.	Yields small to moderate quantities of water to wells. Yields range from 5 to 50 gpm. Higher yields are reported for this interval locally.
			St. Louis Limestone		0-180		
			Salem Formation		0-180		
			Warsaw Formation		0-110		
	Osagean		Burlington-Keokuk Limestone		0-240	Cherty limestone	
			Fern Glen Formation		0-105	Red limestone and shale.	
	Kinderhookian	Chouteau	Undifferentiated		0-122	Limestone, dolomitic limestone, shale, and siltstone.	
Devonian	Upper	Sulphur Springs	Bushberg Sandstone		0-60	Limestone and sandstone.	
			Glen Park Limestone				
			Grassy Creek Shale		0-50	Fissile, carbonaceous shale.	
Silurian			Undifferentiated		0-200	Cherty limestone.	
Ordovician	Cincinnatian		Maquoketa Shale		0-163	Silty, calcareous or dolomitic shale.	Probably constitutes a confining influence on water movement.
			Cape Limestone		0-5	Argillaceous limestone.	
	Champlainian		Kimmswick Formation	2	0-145	Massive limestone	Yields small to moderate quantities of water to wells. Yields range from 3 to 50 gpm. Decorah Formation probably acts as a confining bed locally.
			Decorah Formation		0-50	Shale with interbedded limestone.	
			Plattin Formation		0-240	Finely crystalline limestone.	
			Rock Levee Formation		0-93	Dolomite and limestone, some shale.	
			Joachim Dolomite		0-135	Primarily argillaceous dolomite.	
			St. Peter Sandstone	3	0-160	Silty sandstone, cherty limestone grading upward into quartzose sandstone.	Yields moderate quantities of water to wells. Yields range from 10-140 gpm.
			Everton Formation		0-130		
	Canadian		Powell Dolomite	4	0-150	Sandy and cherty dolomites and sandstone.	Yields small to large quantities of water to wells. Yields range from 10 to 300 gpm. Upper part of aquifer group yields only small amounts of water to wells.
			Cotter Dolomite		0-320		
			Jefferson City Dolomite		0-225		
			Roubidoux Formation		0-177		
			Gasconade Dolomite Gunter Sandstone Member		0-280		
Cambrian	Upper		**Eminence Dolomite**	5	0-172	Cherty dolomites, siltstones, sandstone, and shale.	Yields moderate to large quantities of water to wells. Yields range from 10 to 400 gpm.
			Potosi Dolomite		0-325		
		Elvins	Derby-Doerun Dolomite		0-165		
			Davis Formation		0-150		
			Bonneterre Formation		245-385		
			Lamotte Sandstone		235+		
Precambrian						Igneous and metamorphic rocks.	Does not yield water to wells in this area.

[1] Basal part may be of Pleistocene age.

NOTE: Stratigraphic nomenclature may not necessarily be that of the U.S. Geological Survey.

potential, as they are extensively mined in surrounding areas. Reserves of clay, shale, and gravel are present in the county but are limited in size and by urbanization and land use restrictions. The coal seams in St. Charles County are thin and non-persistent and of little potential.

Engineering Geology

Engineering geology is based upon soil type, rock type, soil thickness, permeabilities, and slopes. The soils in the planning area reflect the geologic history of the area, i.e., they were formed from windblown materials (loess), alluvium, weathered bedrock, and glacial till materials. The bedrock types underlying these soils are limestone and shales, with some chert and dolomite. The limestones are usually characterized by permeabilities associated with solution cavities and jointing, while the shales, dolomites, and cherts are relatively impermeable. Soil thickness, or depth to bedrock, varies considerably over the planning area. The upland areas are generally characterized by thin soil cover; the floodplain areas have thick to very thick soil covers (up to 100 feet) which is alluvial. Most of the soils have low to moderate permeabilities. Slopes in the upland areas range from 2 to 20% while slopes in the floodplains range from 0 to 2%.

3.1.2.2. Soils

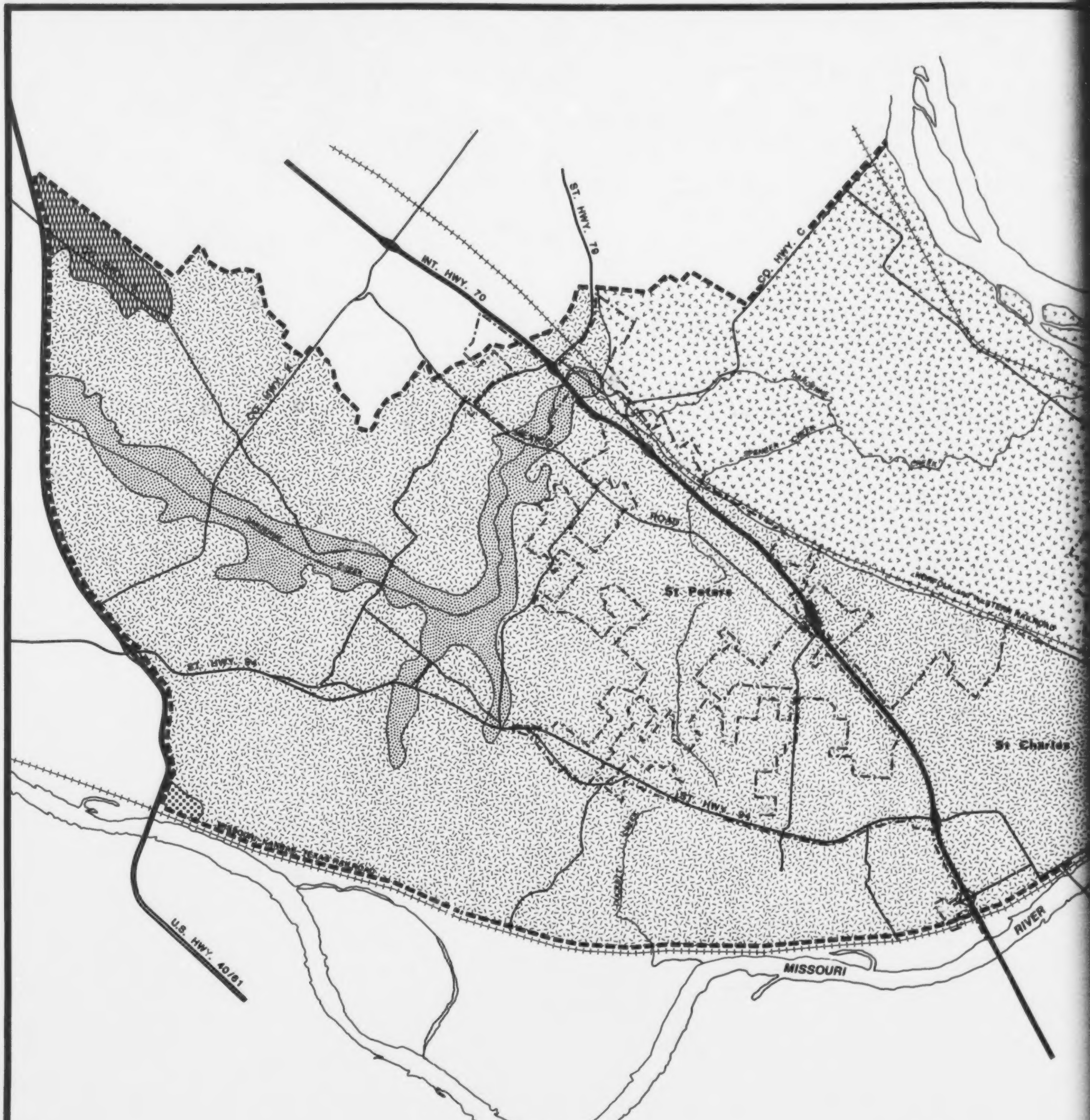
The soil characteristics of an area are an important component of land use planning and utilization. Typical characteristics for differentiating types of soils and in mapping include soil textures of each horizon, permeability, slope, surface drainage, internal drainage, parent material, acidity, available water capacity, flooding, and shrink-swell potential. These factors can be used to evaluate the feasibility of limitations associated with a particular soil area for agricultural crops or landscape plantings, bearing capacity for roads and buildings, drainage, irrigation, liquid waste disposal, and excavated or embankment ponds.

Soils are mapped at a wide range of scales and detail. Soil surveys published by the US Department of Agriculture, Soil Conservation Service (SCS) contain the most detailed maps. These maps are useful for assessing the soils on a farm-size tract. Major soil characteristics are uniform within each individual mapping unit. The SCS has recently published a soil survey of St. Charles County which includes soils maps at a scale of 1:24,000.

Another mapping scale and level of detail is provided by the general soils map (Figure 3-2). Its mapping units are associations, landscapes with a distinctive proportional pattern of soils. This map is prepared by aggregating large areas of soil mapping units from the detailed soil maps. The association normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. One particular soil may occur in several distinctive proportional patterns and thus may be included in several associations.

The general soils map can be used for general purposes on a county basis. These maps can be used to delineate areas suitable for certain types of agriculture, urban development, recreational facilities, and other general land use planning decisions. Within a soil association, considerable variation may exist; therefore, the general soils map must be used with considerable caution. The detailed soils maps should be consulted for information about the soils on a particular tract.

Different soil types are present within the planning area and they exhibit variable thicknesses and engineering characteristics. Extremely thick soils, i.e., greater than 100 ft, exist on the floodplain areas and although the soils on the upland areas are thinner, all of the soils in the planning area are greater than 60 inches, except in localized areas where bedrock outcrops are present. The soils in the planning area are mostly silts and clays and, consequently, have low to high plasticity. Some sands are present in the floodplain areas. The soils generally exhibit low to moderate permeability, depending on the clay content, except in portions of the floodplain areas where sandy soils with high permeabilities are present. The depth to the seasonally high water table generally is between 2 and 6 ft in the upland areas, except in the low-lying areas along the stream bottoms where the water table is less than 2 ft from the surface. In the floodplain areas, the depth to the seasonally high water table generally ranges from 0.5 to 3 ft. The primary constraints to the use of onsite waste treatment systems in the planning area are wetness, periodic flooding, and slow percolation.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CO. HWY. K
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CREEK
ROAD
St. Peters
NORFOLK AND WESTERN RAILROAD
St. Charles
ST. HWY. 94
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
MISSOURI
RIVER

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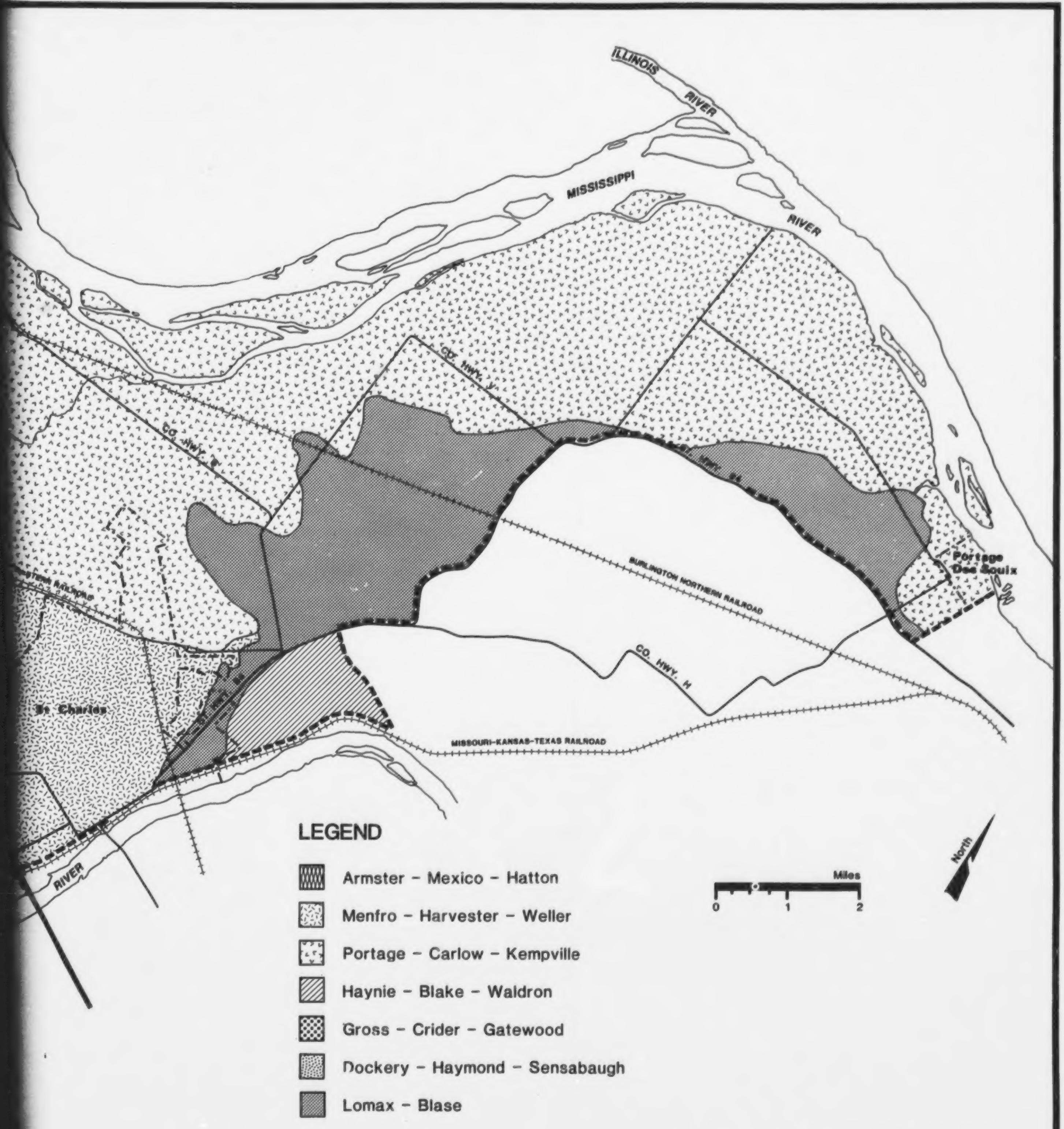
ILLINOIS RIVER
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HWY. 94
BURLINGTON NORTHERN RAILROAD
CO. HWY. H
Portage Des Sioux
St. Charles
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
LEGEND
Armster - Mexico - Hatton
Menfro - Harvester - Weller
Portage - Carlow - Kempville
Haynie - Blake - Waldron
Gross - Crider - Gatewood
Dockery - Haymond - Sensabaugh
Lomax - Blase
Miles
0
1
2
North

Figure 3-2. Soil association.

Description of Soil Associations in the Planning Area

The SCS identified seven soils associations in St. Charles County and five of these occur in the planning area. The soils are derived from glacial material, loess, alluvium, and weathered bedrock. The seven soil associations identified in the planning area are depicted in Figure 3-2 and described below. The general engineering and physical characteristics of the specific soil series present in the planning area are presented in Table 3-3. These characteristics are general and all soils should be tested for site specific properties prior to development.

- Menfro-Harvester-Weller Association -- nearly level to steep, well drained soils formed in loess and silty fill materials; on uplands. The association comprises the majority of the upland portion of the planning area. The association contains approximately 44% Menfro soils, 23% Harvester soils, 23% Weller soils, and 10% minor soils. The soils in this association generally are well suited for building sites and roadways. The soils consist of silts and clays that generally are of low plasticity and have low to moderate shrink-swell potential. However, some of the soils in this association have moderate to high shrink-swell potential in the subsoil which can be overcome by extended footing depths for structures or the addition of granular material on the road bed. Some of the soils in this association, e.g., Harvester soils in the upper horizon, have very slow to moderately slow permeabilities (0.06 to 0.6 inches per hour) which represent a severe limitation to the use of onsite wastewater treatment systems. The permeability of the Menfro soils exceeds 0.6 inches per hour and indicates only slight limitations to the use of onsite systems. Although the permeability of the upper horizon of the Weller soils is moderate (0.6 to 2.0 inches per hour), the permeability in the lower horizons is very slow (0.06 to 0.2 inches per hour) to moderately slow (0.2 to 0.6 inches per hour). Onsite systems placed in Weller soils should be adequately sized and properly constructed to account for the lesser permeability of the soil in the lower horizons.

- Portage-Carlow-Kampville Association -- nearly level, very poorly drained to somewhat poorly drained soils formed in clayey and silty alluvium, on floodplains. This association is present in most of the Mississippi River floodplain in the northern portion of the planning area. This association is comprised of approximately 32% Portage soils, 31% Carlow soils, 9% Kampville soils, and 28% minor soils. Differences in the soils are largely a result of the texture of the materials in which they are formed. The shrink-swell potential of the soils generally is high and they also are generally unsuitable for building construction and roadways because of wetness, flooding, and high clay content. Permeabilities range from very slow to moderate but are generally in the very slow to moderately slow range (-0.06 to 0.6 inches

Table 3-3. Soil characteristics and engineering properties (SCS 1982)

Soils Series	Type	Slope (%)	Erosion Hazard	Permeability Inches Per Hour (depth in inches)	Depth to Water Table (ft)	Flooding Frequency	Shrink-Swell Potential
Armster	Silt loam	5-9	Slight	0.6-2.0(0-20) 0.2-0.6(20-63)	2.5-4.0	None	Moderate-High
Auxvase	Silt loam	0-2	Slight	0.6-2.0(0-13) 0.06(13-29) 0.2-0.6(29-60)	1.0-2.0	Rare	Low-High
Blake	Silty loam	0-2	Slight	0.6-2.0(0-25) 0.6-6.0(25-60)	2.0-4.0	Rare	Low-Moderate
Blase	Silty clay loam	0-2	Slight	0.2-0.6 (0-10) 0.06-0.2(10-32) 0.6-2.0(32-60)	6.0	Rare	Low-High
Booker	Clay	0-2	Slight	0.06(0-60)	0.5-1.0	Frequent	Very High
Carlow	Silty clay loam	0-2	Slight	0.2-0.6(0-8) 0.06(8-60)	0.00-1.0	Occasional	Moderate-High
Carr	Fine sandy loam	0-2	Slight	2.0-6.0(0-34) 6.0-20 (34-60)	6.0	Rare	Low
Chequest	Silt loam	0-2	Slight	0.2-0.6(0-60)	1.0-3.0	Occasional	High
Crider	Silt loam	5-20	Moderate-severe	0.6-2.0(0-60)	6.0	None	Low-Moderate
Dockery	Silt loam	0-2	Slight	0.6-2.0(0-60)	1.0-3.0	Occasional	Low
Dupo	Silt loam	0.2	Slight	0.6-2.0(0-10) 0.2-0.6(10-20) 0.06-0.2(20-60)	1.0-3.0	Frequent	Low-High
Harvester	Urban land	2-14	Moderate-severe	0.2-0.6(0-31) 0.6-2.0(31-67)	6.0	None	Low-Moderate
Haymond	Silt loam	0-2	Slight	0.6-2.0(0-60)	6.0	Occasional	Low

Table 3-3. Soil characteristics and engineering properties (SCS 1982) (Concluded).

Soils Series	Type	Slope (%)	Erosion Hazard	Permeability Inches Per Hour (depth in inches)	Depth to Water Table (ft)	Flooding Frequency	Shrink-Swell Potential
Haynie	Silt loam	0-2	Slight	0.6-2.0(0-60)	6.0	Rare	Low
Herrick	Silt loam	2-5	Slight-moderate	0.6-2.0(0-22) 0.2-0.6(22-60)	1.0-3.0	None	Moderate-High
Hodge	Loamy fine sand	0-2	Slight	6.0(0-60)	6.0	Frequent	Low
Kampville	Silt loam	0-2	Slight	0.6-2.0(0-13) 0.2-0.6(13-60)	1.0-3.0	Occasional	Low-High
Keswick	Silt loam	9-14	Moderate	0.6-2.0(0-8) 0.06-0.2(8-60)	1.0-3.0	None	Moderate-High
Lomax	Loam	0-2	Slight	2.0-6.0(0-60)	6.0	Rare	Low
Menfro	Silt loam	2-30	Moderate-severe	0.6-2.0(0-60)	6.0	None	Low-Moderate
Portage	Clay	0-2	Slight	0.06(0-75)	0.5-1.0	Occasional	Very High
Sensabaugh	Silt loam	0-2	Slight	2.0-6.0(0-60)	4.0-6.0	Occasional	Low
Waldron	Silty clay	0-2	Slight	0.06-0.2(0-60)	1.0-3.0	Rare	High
Weller	Silt loam	0-9	Slight-moderate	0.6-2.0(0-10) 0.06-0.2(10-41) 0.2-0.6(41-63)	2.0-4.0	None	Low-High
Westerville	Silt loam	0-2	Slight	0.6-2.0(0-60)	1.0-3.0	Rare	Low
Winfield	Silt loam	5-20	Slight-moderate	0.6-2.0(0-60)	2.5-4.0	None	Low-Moderate

per hour) due to the clay content. Soils in floodplain areas are very thick, sometimes greater than 100 ft. The use of onsite waste treatment systems is severely constrained by the wetness and slow permeability of the soils.

- Haynie-Blake-Waldron Association -- nearly level, well drained and somewhat poorly drained soils formed in silty, loamy, and clayey alluvium, on floodplains. This association consists of soils on the Missouri River floodplain. Although this association occurs in eastern St. Charles County, it represents a relatively small portion of the planning area (Figure 3-2). This association is comprised of approximately 26% Haynie soils, 26% Blake soils, 16% Waldron soils, and 32% minor soils. As with the Portage-Carlow-Kampville Association, differences in soils in this association are largely a result of the texture of the material in which they were formed. The wetness and flood potential of the association restricts development and road building as well as the use of onsite waste treatment systems. Permeabilities of soils in this assocition vary from very slow to rapid (0.06 to 6.0 inches per hour) depending on the clay or sand content of the soils. The shrink-swell potential also varies from low to high depending on the soil type (sand to clay).

- Dockery-Haymond-Sensabough Association -- nearly level, somewhat poorly drained and well drained soils formed in silty and cherty, loamy alluvium, on floodplains. This association consists of soil formed from alluvial materials and occurs on the floodplain of Dardenne Creek and its tributary streams. This association is comprised of approximately 44% Dockery soils, 16% Haymond soils, 13% Sensabaugh soils, and 27% minor soils. Because of flooding and wetness, the soils in this association generally are unsuitable for building construction and the use of onsite waste treatment systems. The soils generally are greater than 60 inches thick and the shrink-swell potential is low except where occasional plastic clay is present. Permeabilities of these soils range from very slow to moderate (0.06 to 2.0 inches per hour).

- Lomax-Blase Association -- nearly level, well drained and somewhat poorly drained soils formed in loamy, sandy, and clayey alluvium, on terraces. This association is present on a high terrace between the Missouri and Mississippi river floodplains in the northeastern portion of the planning area (Figure 3-2). The terrace rises abruptly to its highest point along the Missouri River floodplain and slopes gradually toward the Mississippi River floodplain. This association is comprised of approximately 40% Lomax soils, 29% Blase soils, and 31% minor soils. The soils exhibit a wide range of characteristics depending on the silty, clayey, or sandy material in which they were formed. The shrink-swell potential ranges from low to very high due to the various material types. Permeabilities range from very slow to rapid (0.06 to 6.0 inches per hour). Most areas of this association are unsuitable for building construction because of potential flooding. In addition, these soils are the most intensively cultivated in St. Charles County and the high value of these soils for agricultural use limits their potential for urban development.

- Armster-Mexico-Hatton Association -- gently sloping and moderately sloping, moderately well drained and somewhat poorly drained soils formed in loess and clayey glacial till, on uplands. This association consists of a partly loess-covered glacial till plain that occupies the northwestern portion of St. Charles County. This association is comprised of approximately 28% Armster soils, 18% Mexico soils, 16% Hatton soils, and 38% minor soils. This association encompasses a small area in the northwestern corner of the planning area along Highway N (Figure 3-2).

- Goss-Crider-Gatewood Association -- moderately sloping to very steep, well drained soils formed in loess and residuum weathered from cherty dolomite, shale, and limestone, on uplands. This association contains cherty and noncherty residual soils on hillsides, ridgetops, and foot slopes. This association occupies a very small part of the planning area near the intersection of Highway 40-61 and the Missouri-Kansas-Texas Railroad. The association contains about 28% Goss soils, 27% Crider soils, 25% Gatewood soils, and 20% minor soils.

General Suitability of Soils for Onsite Treatment Systems

The majority of the residences in the planning area that are not provided with centralized wastewater collection and treatment facilities utilize either septic tanks with soil absorption systems or aerated tanks with surface discharges. According to preliminary estimates by Sverdrup & Parcel and Associates, Inc. (1983b), there are approximately 11,000 residences in the planning area that use onsite systems for waste treatment. The ability of an onsite system to adequately treat domestic wastewater is highly dependent on the existence of aerated soil beneath the drainfield. Other factors which also influence the performance of an onsite system include proper design (sizing), construction, and maintenance.

The primary constraints to the use of onsite systems in the planning area are the depth to the seasonally high water table and the impermeability of the soils. MDNR guidelines recommend a minimum of 4 feet of soil above the water table to allow for adequate nutrient and bacteria removal and pathogen die-off. The soils also must have adequate permeability to prevent backups or ponding of the effluent on the surface. According to the St. Charles County

Soil Survey (SCS 1982), approximately 5% of the planning area soils have slight limitations, approximately 8% have moderate limitations, and approximately 87% are rated as having severe limitations. The ratings are based on soil properties, site features, and the observed performance of the soils.

In the floodplain portion of the planning area, the depth to the seasonally high water table generally is between 0 and 3 ft. Because of the presence of the water table at or near the surface during at least a portion of the year, it is likely that untreated wastewater is entering the alluvial aquifer. The residences in the floodplain areas obtain their drinking water from private wells, with the exception of Portage des Sioux which has a municipal water supply system. Consequently, there is a potential that inadequately treated wastewater from onsite systems is contaminating the water supplies of floodplain area residents.

The soils in the upland area generally have a sufficiently thick unsaturated zone, but the lower permeabilities of the soil affect the operating efficiency of onsite systems. For a soil absorption system to adequately treat wastewater effluent, sufficient pore space must be present in the soil to allow adequate passage and purification of the effluent. Onsite systems constructed in soils with low permeablities, generally below 1.0 inch per hour, can result in ponding of the effluent on the surface with subsequent runoff into surface drainageways. Many of the soils in the upland area have permeabilities in the 0.6 to 2.0 inches per hour range in the upper horizon. In the lower horizons, a significant portion of upland area has soils with permeabilities in the 0.06 to 0.2 inches per hour range (e.g., Weller silt loam). These general conditions indicate that the use of onsite systems in the upland portion of the planning area also is marginal and that site specific investigations are needed before installation of onsite systems to determine whether or not the systems can be expected to operate properly given the characteristics of the soils.

General Suitability of Soils for Treatment of Wastewater Effluent and Sludge by Land Application

Wastewater Effluent -- Land application, or land treatment of wastewater or sludge, utilizes natural physical, chemical, and biological processes in vegetation, soils, and underlying material to renovate and dispose of the waste materials. In addition to treatment of wastewater, the benefits of land application may include recycling of nutrients, timely water applications, groundwater recharge, and soil improvement. These benefits accrue to a greater extent in arid and semi-arid areas but also are applicable in humid areas. The land application of wastewater also may result in additional benefits such as streamflow augmentation during the summer, and the preservation of open space.

Land application of wastewater in Missouri requires a centralized collection and conveyance system, primary treatment, and storage. Disinfection also is needed if there is a discharge to a stream where disinfection is required. A land application site and equipment also would be needed. In addition, collection of the treated water may be included in the system design along with discharge or reuse of the collected water. The optional components may be necessary to meet State requirements or to make the system operate properly.

Treatment of municipal wastewater by land application encompasses a wide variety of possible processes or methods of application. Three principal processes are utilized in the land application component:

- Overland flow
- Slow-rate or crop irrigation
- Rapid infiltration.

In the overland flow process, the wastewater is allowed to flow over a sloping surface on which permanent grass cover is maintained. The grass may be harvested. The method utilizes moderately sloping soils (2 to 6%) with a low infiltration rate. The effluent, which is collected at the foot of the slope, either is discharged to a stream or is stored for further treatment.

The collected effluent generally has an average phosphorus concentration of 4 milligrams per liter (mg/l). Phosphorus removals usually range from 30 to 60% on a concentration basis (USEPA 1977). Filtration by the grass and organic matter, adsorption on the soil particles, and infiltration are responsible for removing the nutrients from the water.

The slow-rate or crop irrigation process involves the application of partially treated wastewater to the land in order to enhance the growth of vegetation. The vegetation is managed so that the maximum amount of nutrients are taken up by the vegetation. The nutrients then are removed by crop harvesting. Water is applied at rates that may range from 0.5 to 4.0 inches per week. The upper 2 to 4 ft of soil is where the major removal of organic matter, nutrients, and pathogens occurs. Processes such as straining, chemical precipitation, and adsorption by the soil are involved. The applied wastewater either is lost to the atmosphere by evapotranspiration or percolates to the water table.

The surface soil must be kept aerobic to ensure that optimum conditions for nutrient removal are maintained. The removal of excess water from the soil is a prime consideration. Site selection depends on the permeability of the soil materials to an approximate depth of 10 ft. Drainage would be considered essential on all of these soils, thus, the present depth to the water table is of little consequence in determining the suitability of the soils for irrigation of sewage effluent.

The rapid infiltration process involves applying effluent to rapidly permeable soils such as sands and loamy sands at rates ranging from 4 to 120 inches per week. Although vegetative cover may be present, it is not an integral part of the treatment process. Cleansing of wastewater occurs within the top few feet of soil by filtration, adsorption, precipitation, and other geochemical reactions.

In most cases, removal of suspended solids (SS), biochemical oxygen demand (BOD), and fecal coliforms is nearly complete. Phosphorus removal can range from 70 to 90% depending on the physical and chemical properties of the wastewater and the soils. Nitrogen removal is less effective unless specific procedures are established to maximize denitrification (USEPA 1977).

In rapid infiltration systems, only minor evapotranspiration occurs. Thus, nearly all of the applied water enters the groundwater. In order for the soil system to purify the wastewater, a minimum of 10 ft of aerobic (unsaturated) soil must be maintained. Some means of removing the groundwater at the site must be present, either by natural flow or through artificial drainage measures. The SCS Soil Survey does not contain information on the material below a depth of 6 ft, thus, the likelihood of finding sites suitable for rapid infiltration cannot be specifically addressed.

Liquid or dewatered sludge may be applied to agricultural or silvicultural land where the separation distances, slope of the land, and the depth to groundwater are adequate. The only criteria dealing with the soil itself are depth to groundwater and land slope.

3.1.2.3. Prime Agricultural Land

Prime farmland is that land best suited for producing food, feed, forage, fiber, and fuel crops, and is available for these uses. The recent inclusion of energy production from biomass as an essential ingredient in land use decisions will increase the emphasis on the continued use of available lands for crop production. The land must have the soil quality, growing season, and moisture supply (either soil water storage or irrigation) to produce sustained high yields of crops economically when treated and managed according to modern farming methods.

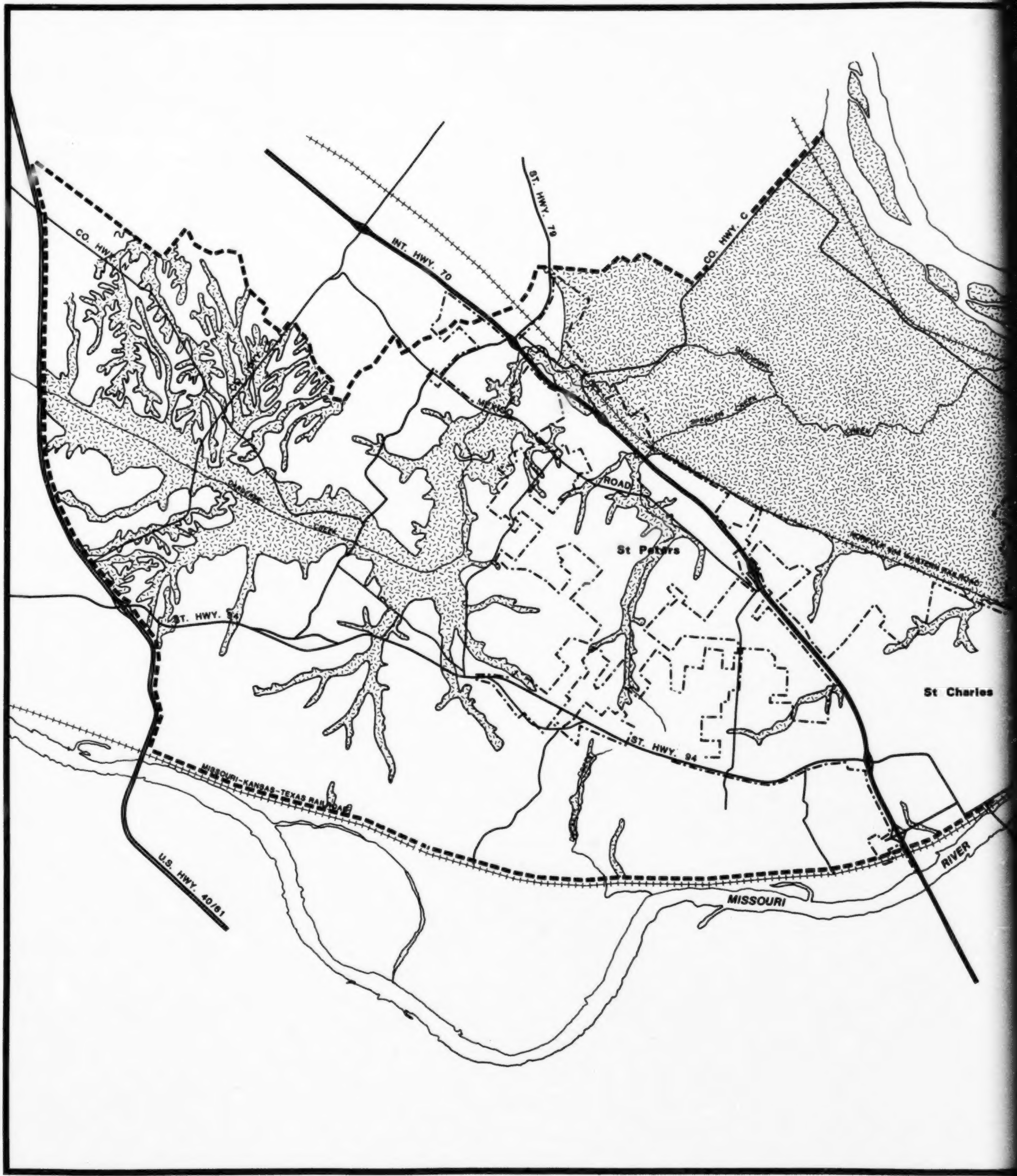
According to the St. Charles County Soil Survey (SCS 1982), about 175,000 acres, or nearly 45% of the county meets the soils requirements for prime farmland. In the planning area, the majority of the prime farmland is located in the Missouri River, Mississippi River, and Dardenne Creek floodplain areas (Figure 3-3). Much of the prime farmaland is suitable, and is used for cultivated crops. The major constraints to optimum yields are wetness and, in some cases, low permeabilities. Many areas of prime farmland in the planning area require drainage control and the scheduling of farm operations requiring heavy machinery during periods when the soil is dry or frozen.

3.1.3. Water Resources

3.1.3.1. Surface Water

Setting and Flow Characteristics

The planning area is located in eastern St. Charles County immediately west of the confluence of the Mississippi and Missouri rivers. Of the 150 estimated square miles in the planning area, 12.8% is in the Lower Missouri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CREEK
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ROAD
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CREEK
NORFOLK AND WESTERN RAILROAD
St Peters
St Charles
ST. HWY. 94
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
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MISSOURI
RIVER

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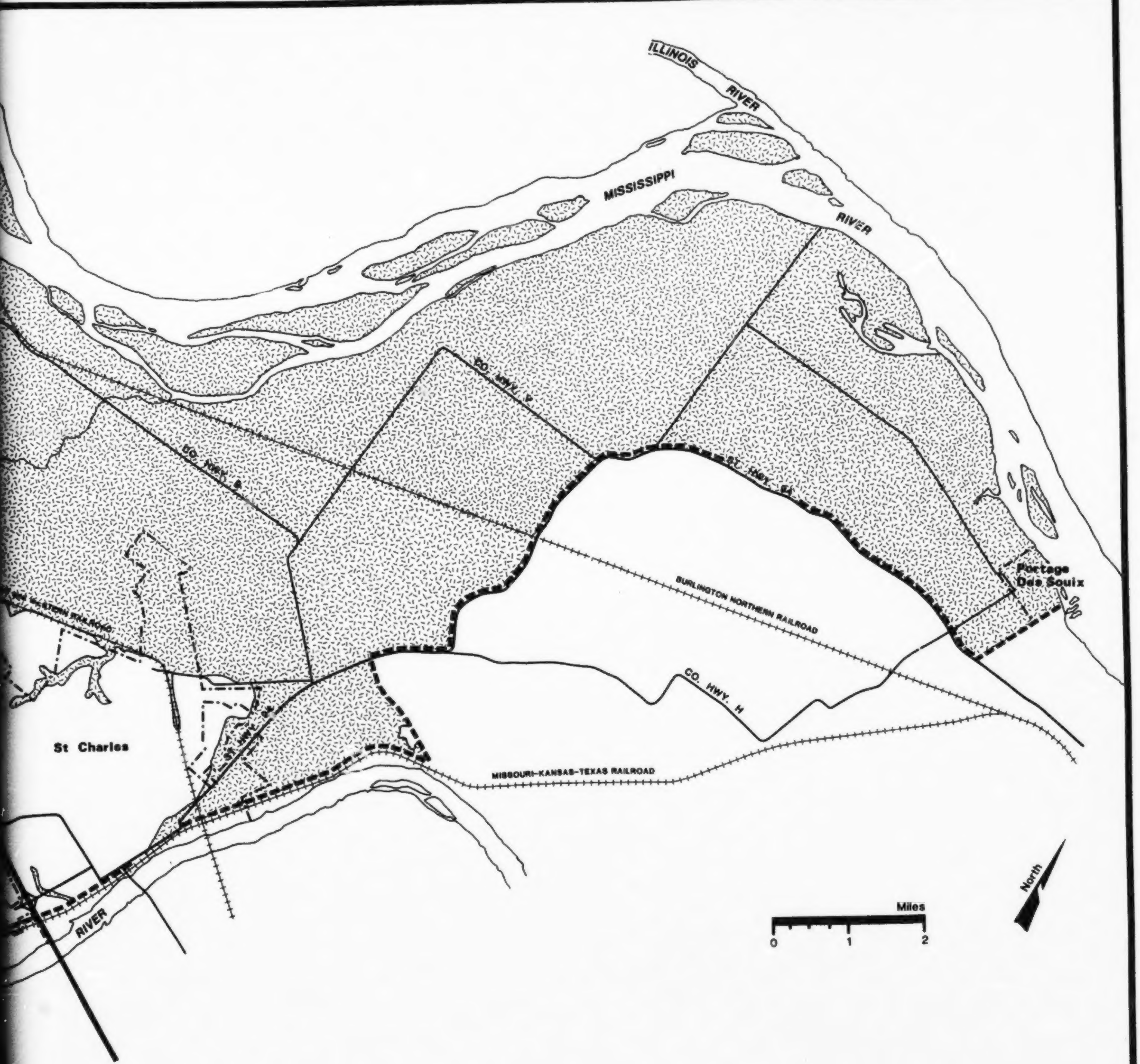
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Portage Des Souix
CO. HWY. H
WESTERN RAILROAD
St Charles
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
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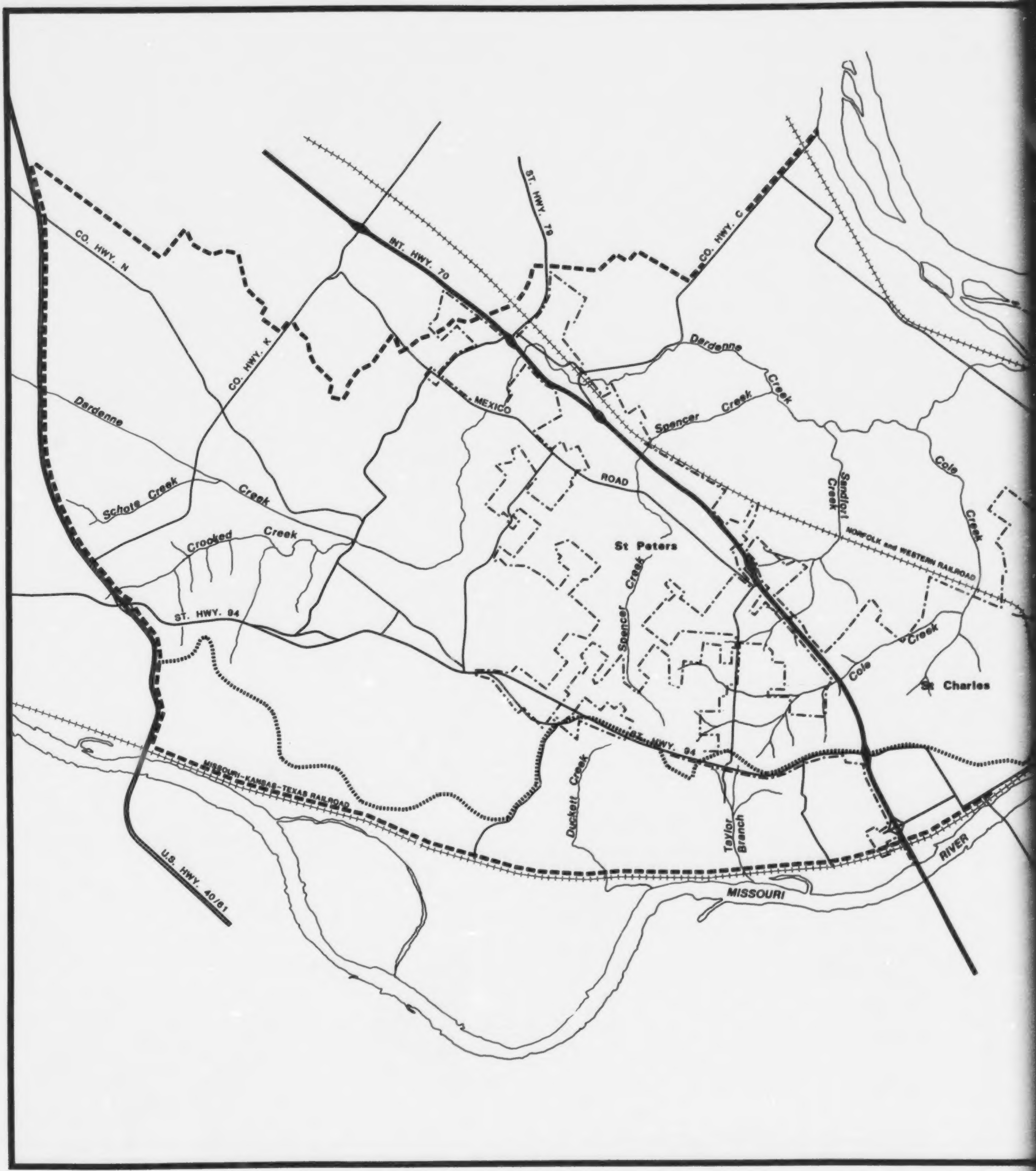
Figure 3-3. Prime farmlands.

River Subbasin (a subbasin of the Missouri River Basin), and 87.2% is in the Upper Mississippi River Basin. As a result of the planning areas location near the confluence of two of the nations largest rivers, the small streams within the planning area are anticipated to have a negligible influence on downstream receiving water quantity and quality.

Six named creeks of low or intermittent flow provide surface water drainage in the planning area (Figure 3-4). These are distributed over the 82 square miles of the deeply incised terrain characteristic of the upland portion of the planning area. Spencer Creek, Cole Creek, Sandfort Creek (which are tributaries of Dardenne Creek) and Dardenne Creek drain into the Mississippi River to the north. Duckett Creek and Taylor Branch (in the Lower Missouri Subbasin) drain into the Missouri River to the south. Drainage area densities of these small streams (river miles per square mile of drainage area) are presented in Table 3-4. In general, stream watersheds with a high stream network density, such as Duckett Creek, are more strongly influenced by nonpoint sources of pollution, and also are more likely to develop localized flooding problems with increased urbanization in the upland areas.

The limited flow data that are available for Dardenne Creek indicate that this small stream has little or no flow in periods typical of low flow conditions, usually August (MDNR 1977). As indicated by the instantaneous discharge data (Table 3-4), flow in Dardenne Creek is variable (0 to 73 cubic feet per second [cfs]) and an even base flow is not sustained. An index of the low flow characteristics of the small streams can be estimated by the 7-day Q2, a statistical figure indicating the annual minimum average discharge sustained for 7 consecutive days every 2 years. The 7-day Q2 is estimated to range from 0.0 to 0.005 cfs per square mile for small streams with drainage areas less than 50 square mile (Skelton 1970). This can be applied to all of the six small streams in the planning area.

In general, the base flows in these Dissected Till Plains streams are small or poorly sustained, and no reasonable estimate of base-flow recessions can be made. For example, seasonal low-flow frequency estimates for the partial record station on Dardenne Creek at County Highway K, have a 7-day low-flow of 0.2 cfs on a 2 year recurrence interval, and 0.0 cfs for a 10 year


CO. HWY. N
CO. HWY. K
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
Dardenne Creek
Spencer Creek
MEXICO
ROAD
Dardenne
Creek
Schote Creek
Crooked Creek
ST. HWY. 94
St Peters
Spencer Creek
Sandfort Creek
Cole Creek
NORFOLK and WESTERN RAILROAD
Cole Creek
St Charles
ST. HWY. 94
Duckett Creek
Taylor Branch
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
MISSOURI
RIVER

3-24.a

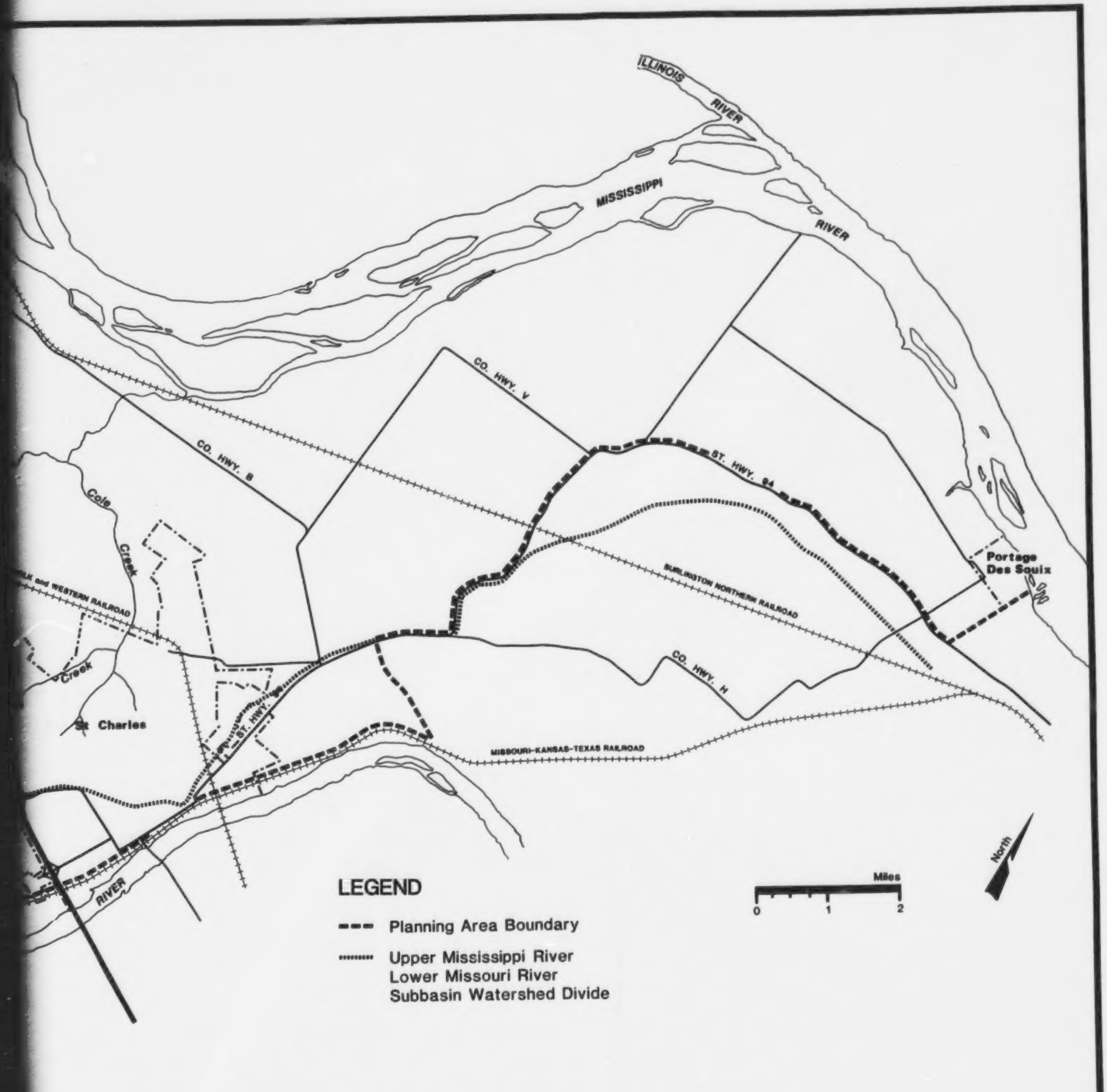

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
Portage Des Souix
Cole Creek
and WESTERN RAILROAD
Creek
St Charles
ST. HWY. 94
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
North
Miles
0
1
2
LEGEND
Planning Area Boundary
Upper Mississippi River Lower Missouri River Subbasin Watershed Divide

Figure 3-4. Surface water.

Table 3-4. Drainage area densities and discharge data (USDI 1967, Missouri Geological Survey 1974, 1977).

Streams	Drainage Area Square Miles	Estimated Stream Lengths (miles)	Drainage Area Densities (miles/sq.mile)	7-day Q2 (cfs)	Average Annual Discharge (cfs)[a]	Instantaneous Discharge (cfs)		
						Date	Location	Flow
Dardenne (except floodplain)	43[b]	24.4	0.57	0 to 0.51	75	12 Sept. 1967	At US Hwy 40/61 and at County Hwy K	0.2[b]
						12 Sept. 1967	At County Hwy C	0.0[c]
						18 Sept. 1967	At US Hwy 40/61	6.6
						03 Dec. 1967	At US Hwy 40/61	73
						15 July 1970	At US Hwy 40/61	3.6
						03 Nov. 1970	At County Hwy K	36.9
Dardenne (floodplain)	10.2	-	-	0.051	2.0			
Spencer	10.1	4.4	0.44	0 to 0.051	7.4			
Duckett	3.8	3.8	1.0	0 to 0.02	2.0			

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[a] Average discharge = (10 inches annual run off x drainage area)/13.6

[b] Total drainage area (including areas outside planning area) is 102 sq. mi.

[c] Typical of median low-flow conditions (7-day Q2).

recurrence interval. The seasonal low-flow data used to calculate these recurrences are applicable for the 3-month period of June through August. More minimum stream flows occurred during the month of August than in any other month, followed by September and October, respectively. For the Dardenne Creek station at Highway 40-61, annual low-flow frequency estimates give a 7-day low flow of 0.1 cfs on a 2 year recurrence interval and 0.0 cfs for a 10-year recurrance interval. This figure is half that of the seasonal low-flow frequency. The limited information cited above indicates that all of the small streams in the area commonly dry up completely in the late summer. Drying out may be an inappropriate characterization because the lack of stream flow during these periods may be due to flow entering the groundwater at the lowered water table elevation of summer.

Urbanization has proceeded at a high rate in the planning area over the last decade and may have a significant influence on flow characteristics of these small streams, especially Spencer and Duckett creeks, because of their small drainage areas. Large areas of urban catchments in these watersheds could significantly increase instanteneous peak flows and decrease base flows by interception of runoff that would previously have recharged the water table aquifers which sustain stream flow in the summer.

Conversely, base flows can in some circumstances be sustained by sump pump discharges, municipal stormwater and effluent discharges, and industrial discharges. No data are available which would indicate that base stream flows have either decreased or increased in the planning area since 1970, the last date of instantaneous stream flow measurements in the area. If attaining water quality standards or determining effluent discharge standards is a concern with these streams, additional investigations would be needed to determine whether or not natural stream flows have been significantly altered by urbanization.

Use and Flow Designations

The MDNR rules for water quality limitations, and for use and flow designations, are specific for the Mississippi River, the Missouri River, and Dardenne Creek (Title 10 CSR 20-7.013). Flow classifications and eight use designations for these streams are listed in Table 3-5, and 28 specific maximum limitations for the designated uses are listed in Table 3-6. Generally, the criteria for the maintainence of Drinking Water Supply Standards and for the Protection of Aquatic Life are the most restrictive.

Table 3-5. Flow classifications and use designation (MDNR 1981; Code of State Regulations, 10 CSR 20-7).

						Designated Use							
Stream or River	Class[1]	Length (miles)	From	To	Counties	Industrial	Drinking Water	Body-Contact Recreation	Commercial Fishing	Aquatic Life	Livestock, Wildlife	Irrigation	Boating
Mississippi River	P	158	Alton L.&D.	Des Moines R.	St. Charles-Clark	●	●	●	●	●	●	●	●
Dardenne Creek	P1	7	Mouth	Sur. 1704	St. Charles					●	●		●
Dardenne Creek	P	15	Sur. 1704	21, 46N. 2E	St. Charles					●	●		●
Missouri River	P	533	Mouth	Iowa State Line	St. Charles-Atchison	●	●		●	●	●	●	●

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[1] Class P: Streams that maintain permanent flow even in drought periods.

Class P1: Standing-water reaches of Class P streams, including impoundments.

Table 3-6. Maximum limitations for designated uses for surface waters (MDNR 1981).

Parameter	Units	Protection of Aquatic Life	Irrigation	Livestock, Wildlife Watering	Whole Body Recreation	Drinking Water Supply
Arsenic	ug/l	50	100			50
Barium	ug/l					1000
Beryllium	ug/l	1100	100			
Boron	ug/l		750			
Cadmium	ug/l	12	10			10
Chlorine (Total Residual)	ug/l	10				
Chromium	ug/l	100	100			
Cobalt	ug/l			1000		
Copper	ug/l	20		500		1000
Cyanide (Free)	ug/l	5				
Iron	ug/l	1000				300
Lead	ug/l	50/100[a]				50
Manganese	ug/l					50
Mercury	ug/l	0.05				2
Nickel	ug/l	100		200		
Selenium	ug/l					10
Silver	ug/l					50
Zinc	ug/l	100/300[a]	2000			5000
Phenol	ug/l					1
Chloride	mg/l					250
Sulfate	mg/l					250
Fluoride	mg/l			2		2
Ammonia-Nitrogen (Un-ionized)	mg/l	0.1				
Nitrate-Nitrogen	mg/l					10
Fecal Coliform Bacteria	per 100 ml				200	
Dissolved Oxygen	mg/l	5(minimum)				
Temperature	°F	90° 5±Change				
Total Dissolved Gases		110% of saturated value				

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[a] Higher value is applicable is total hardness exceeds 300 mg/l.

mg/l = milligrams per liter   1 milligram = 1,000 micrograms

ug/l = micrograms per liter

Specific maximum limitations for each stream are presented in Table 3-7. The Missouri and Mississippi rivers differ for three criteria: beryllium and boron concentrations are stricter for the Missouri River (to qualify for irrigation use); and there is a 200 organism/100 ml fecal coliform bacteria count limit for the Mississippi River (for whole body recreational use). Dardenne Creek is not designated as a drinking water supply or for whole body recreation, therefore, it has less stringent limits for 11 of the 28 criteria.

The 208 Areawide Waste Treatment Management Study for St. Charles County (1977) was prepared prior to the promulgation of the Missouri Water Quality Standards. The 208 study recommended a different set of water quality criteria and uses for the county's rivers and streams (Table 3-8 and Table 3-9). The use classifications in the 208 study differed from those of the State of Missouri in that a private use (e.g., power plant cooling) as well as an aesthetic designation were included. The use classifications are also more comprehensive in that they include more stream reaches (three tributaries to Dardenne Creek as well as a Missouri River tributary) and more criteria. Apparently the MDNR did not incorporate all use designations and water quality criteria from the 208 recommendations because of implementability or other concerns.

In the Water Quality Management Basin Plan, Dardenne Creek is classified as a "water quality limited stream." At present, the Duckett Creek Sewer District's Harvester-Dardenne treatment plant (1 mgd) discharges to a tributary of Dardenne Creek. According to MDNR:

> "The existing (Harvester-Dardenne) plant is receiving flows rapidly approaching its design capacity, and more growth is projected within the service area. The plant does not consistently meet its NPDES permit. The discharge has severely degraded the water quality of the receiving stream which flows through a residential area before merging with Dardenne Creek." (By letter, Mr. John Howland, MDNR, to Mr. Jim Coll, Sverdrup & Parcel & Associates, Inc., 11 March 1983).

Because of the growth that is projected to occur in the service area of the Harvester-Dardenne treatment plant, and the absence of detailed stream data on Dardenne Creek, MDNR performed a study entitled "Waste Load Allocation for the Lower Dardenne Creek", in 1983, to determine the level of

Table 3-7. Specific maximum limitations per stream (MDNR 1981).

Parameter	Units	Missouri River	Mississippi River	Dardenne Creek
Arsenic	ug/l	50	50	50
Barium	ug/l	1000	1000	
Beryllium	ug/l	100	1100	1100
Boron	ug/l	750		
Cadmium	ug/l	10.	10	12
Chlorine (Total Residual)	ug/l	10	10	10
Chromium	ug/l	50	50	100
Colbalt	ug/l	1000	1000	1000
Copper	ug/l	20	20	20
Cyanide (Free)	ug/l	5	5	5
Iron	ug/l	300	300	1000
Lead	ug/l	50	50	50 100[a]
Manganese	ug/l	50	50	
Mercury	ug/l	0.05	0.05	0.05
Nickel	ug/l	100	100	100
Selenium	ug/l	10	10	
Silver	ug/l	50	50	
Zinc	ug/l	100 300[a]	100 300[a]	100 300[a]
Phenol	ug/l	1	1	
Chloride	mg/l	250[b]	250[b]	(see c)
Sulfate	mg/l	250[b]	250[b]	(see c)
Fluoride	mg/l	2.0	2.0	2.0
Ammonia-Nitrogen (Un-ionized)	mg/l	0.1	0.1	0.1
Nitrate-Nitrogen	mg/l	10	10	
Fecal Coliform Bacteria	per 100 ml		200	
Dissolved Oxygen	mg/l	5 (minimum)	5 (minimum)	5 (minimum)
Temperature	F	90° 5° Change	90° 5° Change	90° 5° Change
Total Dissolved Gases		110% of saturation value	110% of saturation value	110% of saturation value

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[a] Higher value is applicable if total hardness exceeds 300 mg/l.

[b] Lower of 2 values shall apply: 250 mg/l or that specified by subsection (5) (L) as in 10 CSR 20-7.031.

[c] See subsection (5) (L) of 10 CSR 20-7.031.

Table 3-8. Surface water uses in St. Charles County by stream reach under the 208 criteria (EWGCC 1978).

Stream Reach	Secondary Contact Recreation	Primary Contact Recreation	Aesthetics	Power Plant Cooling	Industrial Water Supply	Agricultural Irrigation	Wildlife and Livestock Watering	Public Water Supply	Warm Water Fishery
Missouri River Basin									
Missouri River		•	•	•	•	•	•	•	•
Duckett Creek	•		•				•		•
Upper Mississippi River Basin									
Upper Mississippi River		•	•	•	•	•	•	•	•
Lower Dardenne Creek	•		•			•	•	•	•
Upper Dardenne Creek	•		•			•	•	•	
Cole Creek	•		•			•	•		
Spencer Creek	•		•			•	•		
Sandfort Creek	•		•			•	•		

Table 3-9. Recommended water quality evaluation under the 208 criteria (EWGCC 1977).

Parameter	Secondary Contact Recreation	Primary Contact Recreation	Aesthetics	Power Plant Cooling	Industrial Water Supply	Agricultural Irrigation	Wildlife and Livestock Watering	Public Water Supply	Warm Water Fishery
Alkalinity	-	-	-	500	80-150	-	30-130	-	20 minimum
Aluminum	-	-	-	3.0	-	9.0	5.0	-	-
Aquatic Growth	Virtually free(1)	Virtually free(1)	Virtually free(1)	-	-	-	No blue-green algae	-	-
Arsenic	-	-	-	-	-	0.10	0.2	0.05	0.05
Bacteria									
Fecal Coliform	1,000/100ml(3)	200/100ml(2)	-	-	-	1,000/100ml	-	2,000/100ml	-
Total Coliform	-	-	-	-	-	-	-	10,000/100ml	-
Barium	-	-	-	-	-	-	-	1.0	5.0
Beryllium	-	-	-	-	-	0.10	-	-	0.011-1.1(8)
Bicarbonate	-	-	-	600	480	-	-	-	-
Boron	-	-	-	-	-	0.75	5.0	0.75	-
Cadmium	-	-	-	-	-	0.01	0.050	0.010	0.0004-0.015(8)
Calcium	-	-	-	500	200	-	-	-	-
Chloride	-	-	-	600	100	100	-	250	-
Chlorine	-	-	-	-	-	-	-	-	0.003
Chromium	-	-	-	-	-	0.10	0.05	0.050	0.05
Cobalt	-	-	-	-	-	0.05	1.0	-	-
Color	-	Virtually free(1)	Virtually free(1)	-	10 units(5)	-	-	75 units(5)	-
Copper	-	-	-	-	-	0.2	0.5	1.0	0.010-0.040(8)
Cyanide	-	-	-	-	-	-	-	0.2	0.005
Floating Debris and Scum	Virtually free(1)	Virtually free(1)	Virtually free(1)	-	-	-	-	-	-
Fluoride	-	-	-	-	1.0	1.0	2.0	1.8(6)	-
Hardness	-	-	-	850	900	-	-	-	-
Iron	-	-	-	14	1.0	5.0	-	0.3	0.8
Lead	-	-	-	-	-	5.0	0.1	0.05	0.004-0.150(8)
Lithium	-	-	-	-	-	2.5	-	-	-
Magnesium	-	-	-	-	30	-	-	-	-
Manganese	-	-	-	2.5	.01	0.2	-	0.05	1.0
Mercury	-	-	-	-	-	-	0.0005	0.002	0.00005
Nickel	-	-	-	-	-	0.20	-	-	0.050-0.400(8)
Nitrogen									
Ammonia (NH_3-N)	-	-	-	-	0.5	-	-	0.5	0.020 (un-ionized)
Nitrate (NO_3-N)	-	-	-	30	8	-	-	10.0	-
Nitrite (NO_2-N)	-	-	-	-	-	-	10	1.0	-
Nitrite + Nitrate	-	-	-	-	-	-	100	-	-
Odor (Objectionable)	Virtually free(1)	Virtually free(1)	Virtually free(1)	-	Low	-	-	Virtually free(1)	-
Oil	Virtually free(1)	Virtually free(1)	Virtually free(1)	-	1	-	No visible floating	Virtually free(1)	No visible floating
Organics									
Carbon Chloroform Extract	-	-	-	-	-	-	-	0.7	-
Chlorophyll a	-	-	0-4 mg/m^3	-	-	-	-	-	-
Polychlorinated Biphenyls (PCB)	-	-	-	-	-	-	-	0.001	0.000001
Oxygen, Dissolved	-	-	-	-	Aerobic	-	Aerobic	-	1.0-9.3(9)(10)
pH	-	6.5-8.3	-	5.0-8.9	6.5-9.0	4.5-9.0	7.0-9.2	5.0-9.0	6.5-9.0
Phenols	-	-	-	-	-	-	-	0.001	0.001
Phosphate (Total)	-	-	0.05(4)	4	-	-	-	-	-
Selenium	-	-	-	-	-	0.020	0.05	0.010	0.050
Silica	-	-	-	50	50	-	-	-	-
Silver	-	-	-	-	-	-	-	0.05	0.00010-0.00050(8)
Solids									
Settleable	-	Virtually free(1)	Virtually free(1)	-	-	-	Minimized	-	-
Suspended	-	-	-	5,000	5,000	-	-	-	80
Total Dissolved	-	-	-	1,000	500	2,000	3,000(7)	500	2,000
Sulfate	-	-	-	680	570	200	-	250	-
Sulfide	-	-	-	-	0.2 H_2S	-	-	-	0.002 undissociated H_2S
Temperature									
Minimum	-	13°C (59°F)	-	-	-	-	Avoid change in freezing dates	-	-
Maximum	-	35°C (94°F)	-	38°C (100°F)	38°C (100°F)	-	-	-	29.9°C (85.8°F)
Vanadium	-	-	-	-	-	0.10	0.1	-	-
Zinc	-	-	-	-	-	2.0	25.0	5.0	0.050-0.060(8)

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(1) Virtually free is used to imply freedom from the undesirable effects of the constituent itself. This recognizes the practical impossibility of complete absence and the inevitability of the presence of potential pollutants to some degree.

(2) Log mean of a minimum of five samples collected over 30 days. Ten percent of the total samples for any 30-day period shall not exceed 400/100ml.

(3) Log mean of a minimum of five samples collected over 30 days. Ten percent of the total samples for any 30-day period shall not exceed 2,000/100ml.

(4) Suggested standard for streams. Suggested standard for lakes is 0.025 mg/l.

(5) Platinum-cobalt units.

(6) Based on the average annual maximum daily air temperature of 18.6°C (65.5°F).

(7) As close to natural conditions as possible. Rapid fluctuations should be minimized.

(8) Value dependent on the hardness as shown by Davies and Goettl, July 1976.

(9) See Figure 2.3.

(10) For stress which have low dissolved oxygen concentrations due to pollution, a minimum value is 5 mg/l.

treatment required at the proposed wastewater treatment plants to protect the water quality of Dardenne Creek. The study (see Appendix A to Final 201 Facilities Plan--Sverdrup & Parcel, Inc., 1984) concludes that the Harvester-Dardenne discharge be eliminated and that the St. Peters plant be upgraded to include nitrification facilities.

Point and Nonpoint Source Pollution

The 208 study reported qualitatively, the sources of significant pollution to the Mississippi and Missouri rivers as well as to the smaller streams in the planning area. These conclusions drew on information developed from 1963 to 1977. Dardenne Creek and its tributaries are subject to pollution from point sources, nonpoint sources, and undersized or failing onsite systems. According to the 208 study, Duckett Creek is subject to non-point runoff from both rural and urban sources. The planning area and stream reaches defined in the 208 study are generally broader than those for the planning area.

The MDNR National Pollutant Discharge Elimination System (NPDES) permits provide information on permitted discharges to streams. Effluent discharge data for the public and private wastewater treatment plants in the planning area are listed in Table 3-10. Nine of the 16 treatment plants in the planning area with effluent discharges had BOD and/or TSS concentrations in excess of their NPDES permit limits for one or more of the reporting periods from October 1981 through September 1982 (see Table 3-10). Notable BOD and TSS violations occurred for the City of St. Charles Missouri River treatment plant (Missouri River receiving stream) and also for the City of St. Peters, Spencer Creek treatment plant (TSS violation; Spencer Creek receiving stream).

A comparison of effluent discharge flow rates, with both average and 7-day Q2s (Table 3-4) for the small streams, shows that the facility discharges may greatly exceed the estimated stream flows. During periods of low stream flow in Dardenne, Spencer and Duckett creeks, effluent discharges would account for a majority of the flow volume in those streams.

Table 3-10. Average BOD_5 and TSS effluent concentrations from wastewater treatment plants in the planning area (based upon NPDES discharge reports from MDNR for 1980, 1981, and 1982).

Plant	Flow (MGD)	Receiving Stream	BOD_5 (mg/l)	TSS (mg/l)
• Duckett Creek Sewer District				
Duckett Creek Treatment Plant	.536	Duckett Cr.	26	28
Harvester-Dardenne Treatment Plant	.890	Dardenne Cr.	35*	32*
Highway 94 South Treatment Plant	.007	Dardenne Cr.	Not Available	
Boschertown Lagoon	.167	Missouri R.	36*	44
• City of St. Charles				
Mississippi River Treatment Plant	4.1	Mississippi R.	12	9
Missouri River Treatment Plant	3.18	Missouri R.	97*	67*
St. Charles Trails	.030	Taylor Brook Cr.	27	66
Heatherbrook Lagoon	.052	Missouri R.	47*	80*
• City of St. Peters				
Spencer Creek Treatment Plant	1.72	Spencer Cr.	16	46*
• City of Portage des Sioux				
Septic Tank	.017	Mississippi R.	85*	117*
Yacht Club of St. Louis	.014	Mississippi R.	Not Available	
Martell Subdivision	.013	Dardenne Cr.	Not Available	
St. Joseph Church and School	.001	Dardenne Cr.	Not Available	
Tee Kay Mobile Manor	.011	Schote Cr.	60*	91*
Riverview Hills Subdivision	.002	Missouri R.	12	332*
Timbercrest Subdivision	Not Avail.	Missouri R.	Not Available	

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*Exceeds NPDES limits.

For complete listing of all facility NPDES permits, See Appendix B to Final 201 Facilities Plan.

Qualitative water quality violations for streams in the planning area evaluated by the 208 study were based upon statistical summaries of data collected between 1963 and 1976. The Mississippi River had alkalinity, iron, and zinc concentrations in excess of the 208 criteria, and the Missouri River had iron concentrations in excess of the criteria. However, a comparison of data for 208 recommended levels and MDNR limits, indicates that the concentrations of mercury, fecal coliform, and ammonia in the Mississippi River, and mercury and fecal coliform in the Missouri River are in excess of these limits. The 208 water quality evaluations were based upon statistical summaries of data collected a decade earlier and hence may not reflect current in-stream qualities for the planning area's rivers.

Water Quality of Small Streams

Water quality data for the small streams in the planning area are limited to samples collected from Dardenne Creek in 1967 and 1970 (Table 3-11). As indicated by the high calcium and alkalinity concentrations, Dardenne Creek may be classified as a calcium-bicarbonate type.

The high ratios of fecal coliform to fecal streptococci in one sample (July 1970) indicate pollution from a human waste source. A reconnaissance of Dardenne and Spencer creeks by the MDNR has shown water quality, by visual inspection, to be poor. Algal growth was noted immediately downstream of the effluent discharged from the Duckett Creek Sewer District's Harvester-Dardenne treatment plant (Personal communication, Mr. John Lodderhose, MDNR, to WAPORA, Inc., April 1983). Additionally, the Harvester-Dardenne plant is currently operating at or near its capacity of 1 mgd. A 1983 waste load allocation study of Dardenne Creek (Appendix A to Final 201 Facilities Plan) recommended the elimination of the Harvester-Dardenne discharge to Dardenne Creek.

3.1.3.2. Groundwater

Geohydrology and Aquifer Characteristics

Groundwater in the planning area occurs in the underlying alluvium and bedrock aquifers. The alluvial aquifers underlying the Mississippi and Missouri river floodplains are the primary sources of groundwater in the planning

Table 3-11. Water quality for Dardenne Creek near Weldon Spring, Missouri (Missouri Geologic Survey and Water Resources, 1974 and USDOI, 1967).

Parameter	Units	Date Sampled			
		18 Sept. 1967[a]	13 Dec. 1967[a]	15 July 1970[b]	3 Nov. 1970[b]
Temperature	°F	69.8	42.8°	76.1	48.2
Silica	mg/l as SiO_2	10	12	12	12
Iron	mg/l as Fe	0.06	0.34	2.8[a]	1.0[a]
Manganese	mg/l as Mn	0.07	0.13	0.62[a]	0.16[a]
Calcium	mg/l as Ca	61	34	60	47
Magnesium	mg/l as Mg	2.0	6.2	9.0	7.7
Sodium	mg/l as Na	7.8	7	8.3	6.2
Potassium	mg/l as K	3.1	2.9	2.1	2.3
Bicarbonate	mg/l as HCO_3	240	113	232	170
Sulfate	mg/l as SO_4	2	23	16	24
Chloride	mg/l as Cl	7	5.2	6.2	5.7
Fluoride	mg/l as F	0.2	0.2	0.2	0
Nitrate	mg/l as NO_3	0.3	0.9	0.4	5.2
Dissolved solids	residue @ 180°C	232	147	252	205
Specific conductivity	umhos @ 25°C			400	340
pH		8	7.3	8.0	7.6
Dissolved oxygen	mg/l	6.6	11.2	5.1	10.3
Percent saturation		73	90	61	89
Total coliform	colonies/100 ml			5,800	880
Fecal coliform	colonies/100 ml			5,000	110
Fecal strep.	colonies/100 ml			1,500	230
Phosphate	mg/l as PO_4	0.04	0.12		
Turbidity	JTU	30	8		
Ammonia nitrogen	mg/l as N	0.06	0.05		

[a] at U.S. Highway 40-61

[b] at County Highway K

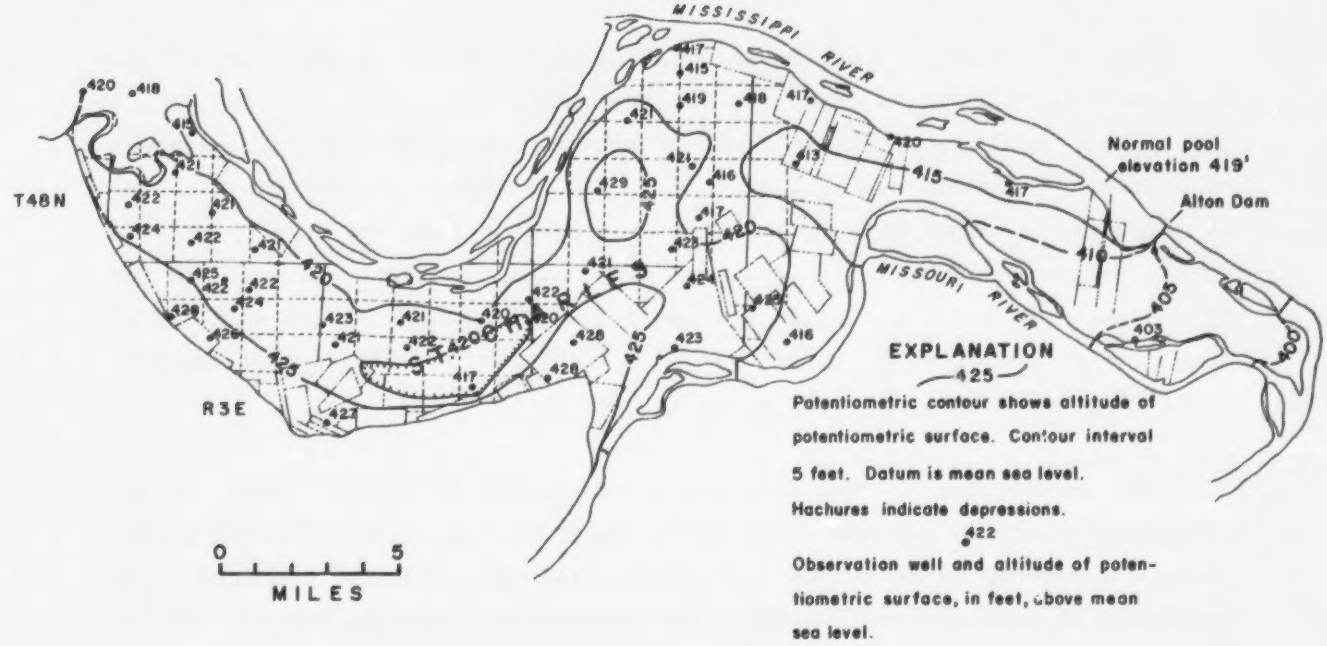
area. Most of the larger utilities use these aquifers for their water source. Some smaller utilities and individual users use the bedrock aquifers that underlie the uplands of the planning area. Few wells penetrate the bedrock aquifer underlying the floodplain alluvium because adequate water supplies are available in the alluvium.

The total thickness of the alluvium ranges from 0 to 120 ft within the planning area (Figure 3-1). The greatest extent of the alluvial floodplain has depths to bedrock from 90 to 120 ft. The alluvium generally consists of fine sand, silt, and clay in the upper part, and sand and gravel in the lower part.

The alluvium has a relatively high rate of recharge because the surface soils have rapid infiltration rates and the nearly level soils allow an opportunity for infiltration along time. Recharge also occurs during sustained high stream flows and overbank flooding. Some recharge of the alluvium also is expected to occur from upward movement of water from the underlying bedrock. The extent of recharge from precipitation alone to the alluvial aquifer is estimated to be 0.37 million gallons per day (mgd) per square mile for an area of alluvium (East St. Louis) which is similar to the Mississippi and Missouri river alluvium within the planning area (Schicht 1965).

The groundwater in the alluvium occurs under unconfined (water table) conditions except in certain areas where lenses of clay create confined conditions and perched water tables. In these locations, confined conditions are typically of limited areal extent. The groundwater table map for the Mississippi River alluvium is shown in Figure 3-5. The water levels range in elevation from 415 to 430 feet msl. The depressed contour north of St. Charles probably is due to pumping wells in the area. Groundwater movement in the alluvial aquifers is generally toward the rivers where discharge into wetland areas and streambank seepage occurs. Movement of groundwater toward the pumping wells also takes place within the planning area.

The bedrock aquifers are not utilized to the extent that the alluvial aquifers are utilized, yet these bedrock units constitute an important source of domestic water supplies in the planning area. The generalized stratigra-



MISSISSIPPI RIVER
MISSOURI RIVER
ST. CHARLES
T48N
R3E
Normal pool elevation 419'
Alton Dam
0
5
MILES
EXPLANATION
425
Potentiometric contour shows altitude of potentiometric surface. Contour interval 5 feet. Datum is mean sea level. Hachures indicate depressions.
422
Observation well and altitude of potentiometric surface, in feet, above mean sea level.

Source: Water Resources of the
St. Louis Area, Missouri;
Missouri Geological Survey
and Water Resource,
Miller et al. 1974.

Figure 3-5. Groundwater table aquifers for the Mississippi River alluvium

phic column and water yielding properties are displayed in Table 3-2 and a generalized cross-section is shown in Figure 3-1. No data are available on the actual thicknesses of the bedrock units within the planning area. The bedrock aquifers are predominantly composed of dolomite with some units composed of limestone, sandstone, and shale.

Predominant bedrock aquifers are:

- The Post-Maquoketa (Group 1) includes all bedrock units overlying the Maquoketa Shale (Table 3-2), which probably acts as a confining bed (Miller et al. 1975). The thickness of this aquifer within the planning area ranges from 150 to 350 feet. It is generally present over the entire planning area, although its saturated thickness is adequate for high productivity wells only to the east of the Dardenne Creeke valley. The bedrock units in this aquifer are relatively impermeable and yield small to moderate quantities of water.
- The Kimmswick-Joachim (Group 2) yeilds sufficient quantities for domestic supplies but is not an important aquifer in the planning area.
- The St. Peter-Everton (Group 3) is comprised of the St. Peter Sandstone and the Everton Formation. Moderate quantities of water are available to wells, and public water supply wells developed in this group are feasible.
- The Powell-Gasconade (Group 4) is comprised of five units that are mostly dolomites with some sandstone layers. Water yields in this group range from low to high depending on localized conditions within the aquifer.
- The Eminence-Lamotte (Group 5) overlies the Precambrian basement bedrock. The group consists of dolomites, siltstone, sandstone, and shale. It yields moderate to large quantities of water to wells.

Recharge of the bedrock units occurs principally where these units constitute the bedrock surface. Some leakage between bedrock groups occurs but is not likely to be the principal recharge source. The bedrock surface within the planning area is presented in Figure 3-1. Groups 2, 3, and 4 are exposed in the southwestern part of St. Charles County near the Missouri River. Group 5 is exposed in areas farther to the west, primarily in deeply incised river valleys. Information on the piezometric surface within the bedrock aquifers specific to the planning area is not available.

Discharges from the bedrock units within the planning area are probably minimal. Some leakage to the alluvium in the river valleys likely occurs but the extent and quantity are not known.

Well Yields, Uses, and Quality

The alluvium in the floodplains of the Mississippi and Missouri rivers constitute the most important aquifers in the planning area. High capacity wells can be developed in either valley. At the former Weldon Springs Ordnance well field (approximately 5 miles southwest of the planning area in the Missouri River alluvium), a well was test pumped at 2,650 gallons per minute (gpm) for 47 hours (Emmett and Jeffery 1968). Irrigation wells capable of supplying greater than 3,300 gpm have been reported (Miller et al. 1974) in the Mississippi River alluvium. Most wells have capabilities near 1,000 gpm.

The alluvial aquifers are used extensively for water supplies for the area communities (Table 3-12). Other sources of potable water - bedrock wells and the Missouri River - are used minimally for public water supplies (MDNR 1982b). Private water supplies utilize bedrock wells and alluvial wells. Information on the number and pumping rates of these wells is not available.

The quality of the water from the alluvium is variable, but generally has high iron and manganese concentrations and high total dissolved solids. Compared to the drinking water quality standards, the iron and manganese concentrations greatly exceed the standards (0.3 and 0.05 mg/l, respectively). Concentrations of iron in the alluvial aquifer range from 1.0 to 29 mg/l, while concentrations of manganese range from 0.15 to 2.7 mg/l (Miller et al. 1974). Because of these high concentrations, public water suppliers utilize iron and manganese removal facilities (MDNR 1982). The total dissolved solids concentrations range from 205 to 690 mg/l (drinking water standard is 500 mg/l; Miller et al. 1974).

Chloride concentrations in the alluvial aquifers vary widely, ranging from 0.5 mg/l (Miller et al. 1974) to 210 mg/l (MDNR 1982). The water supply wells used by St. Peters have high concentrations of chlorides (standard is 250 mg/l), while few other wells have high concentrations. Chlorides are likely migrating upward from saline bedrock through improperly sealed bedrock wells or through porous zones in the bedrock (City of St. Peters 1982).

Table 3-12. Groundwater source and use within the planning area.

Public Water Supply	Source	Consumption (mgd)	Water Treatment
Cities			
• Portage Des Sioux	1 alluvial well	0.02	Iron removal, chlorination
• St. Charles-Elm Point	5 alluvial wells	4.00	Iron removal, softening, chlorination
• St. Peters	5 alluvial wells	1.50	Iron removal, softening, chlorination
Utility			
• St. Charles County			
Weldon Springs Plant	4 alluvial wells	2.73	Iron removal, softening, chlorination
North Plant	4 alluvial wells	0.67	Chlorination

The bedrock aquifers in the upland portion of the planning area are important water sources for individual homes and subdivisions. Some communities to the west of the planning area also utilize the bedrock aquifers. Within the planning area, approximately five subdivisions and four mobile home parks have wells in the bedrock aquifers (MDNR 1982). These utilize relatively small volumes of water. Generally, bedrock wells yield limited quantities of water, typically less than 150 gpm, although some high capacity wells can be developed.

The quality of the water in the bedrock aquifers is highly variable, with the quality being poorer near the Mississippi River. The river bottoms are the discharge areas for the deep bedrock aquifers and these highly mineralized waters move upward through the bedded layers in areas where fissures occur and through improperly sealed wells. Generally, the water is used without treatment (MDNR 1982). Some wells within the planning area have iron concentrations higher than the standard of 0.3 mg/l (Miller et al. 1974; MDNR 1982). The chloride concentrations in some wells are greater than 1,000 mg/l, although the concentrations are less than 50 mg/l in most bedrock wells. Fluoride concentrations in some wells are greater than the standard of 2.2 mg/l. Radionuclides in some bedrock wells exceed the recommended maximums of the State (MDNR 1981). The bedrock wells serving the Belleau Gardens Mobile Home Park and Belleau Lake Estates are listed as exceeding the contaminant levels.

3.1.3.3. Floodplains

Large floods on the smaller streams in the planning area occur during any season of the year, but are most frequent during the months of March through May. Although heavy spring rains cause many of the floods, the two largest floods of record occurred during June. These early summer floods were the result of intense local thunderstorms that flooded small tributaries which subsequently flooded larger streams (Missouri Geological Survey 1975).

No flood control reservoirs exist in the planning area. However, several creeks in the planning area have undergone channel modifications to reduce the potential for flood damage. Privately built levees have eliminated or minimized flood damage from low frequency floods in some stream reaches. These levees generally do not provide protection against a 100-year flood. A summary of maximum recorded floods and stages at USGS gaging stations in the vicinity of the planning area is presented in Table 3-13.

Table 3-13. Summary of maximum recorded floods and stages (USGS 1981).

Station Name	Drainage Area (Sq.Mi.)	Date of Maximum Discharge	Height[1] (Ft Above Mean Sea Level)	Flood Discharge (cfs)
Mississippi River at Alton	171,500	29 Apr. 1973	432.1	535,000
Missouri River at Hermann[2]	528,200	June 1844	517.0	892,000
Mississippi River at St. Louis	701,000	27 June 1844	423.17	1,300,000

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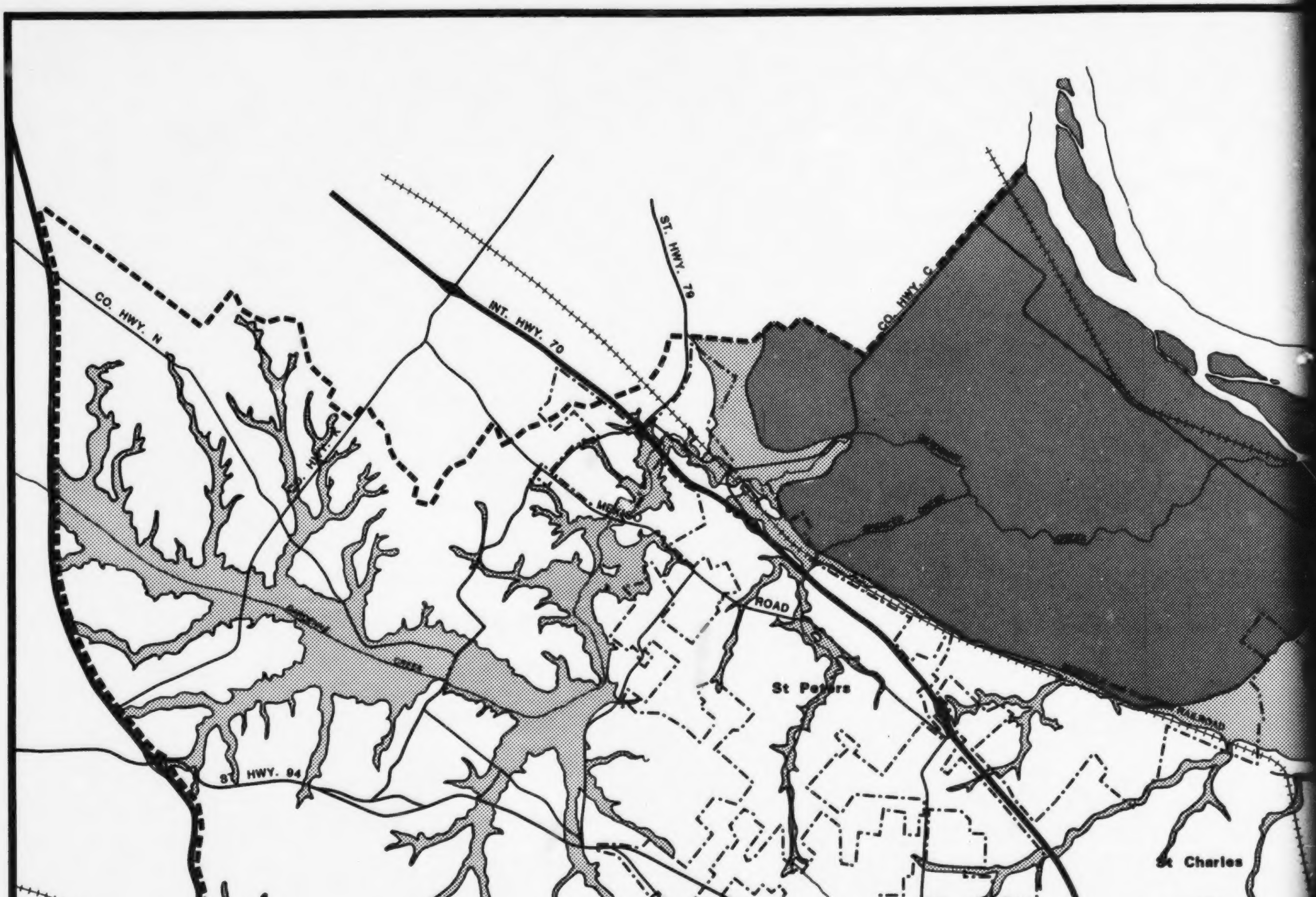
[1] Did not necessarily occur at same time as maximum discharge.
[2] Inflow between Hermann and the mouth of the Missouri River is insignificant.

The flood of record on the Mississippi River occurred in the spring of 1973 (Figure 3-6). The area extending from Elm Point to the Village of Portage des Sioux is topographically higher than the surrounding floodplain and was not covered by flood waters. The Missouri River is almost completely controlled by an extensive reservoir system in its headwater areas, which moderates the downstream flood potential. However, the Mississippi River is not significantly controlled at medium and high stages above its confluence with the Missouri, and therefore, flooding is a more frequent problem on the Mississippi River in the vicinity of the confluence.

Nearly all of the Mississippi and Missouri river bottomlands are subject to flooding during a 100-year flood (Figure 3-6). An exception is a small area bounded by the 450 foot elevation contour, which extends from Elm Point northeastward (Figure 3-6). The elevations of the 100-year floodplain have been determined by the US Army Corps of Engineers (COE) and the elevations at the planning area boundaries are shown in Table 3-14.


CO. HWY. N
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
ROAD
St Peters
St Charles
ST. HWY. 94
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
MISSOURI
RIVER

3-44.a

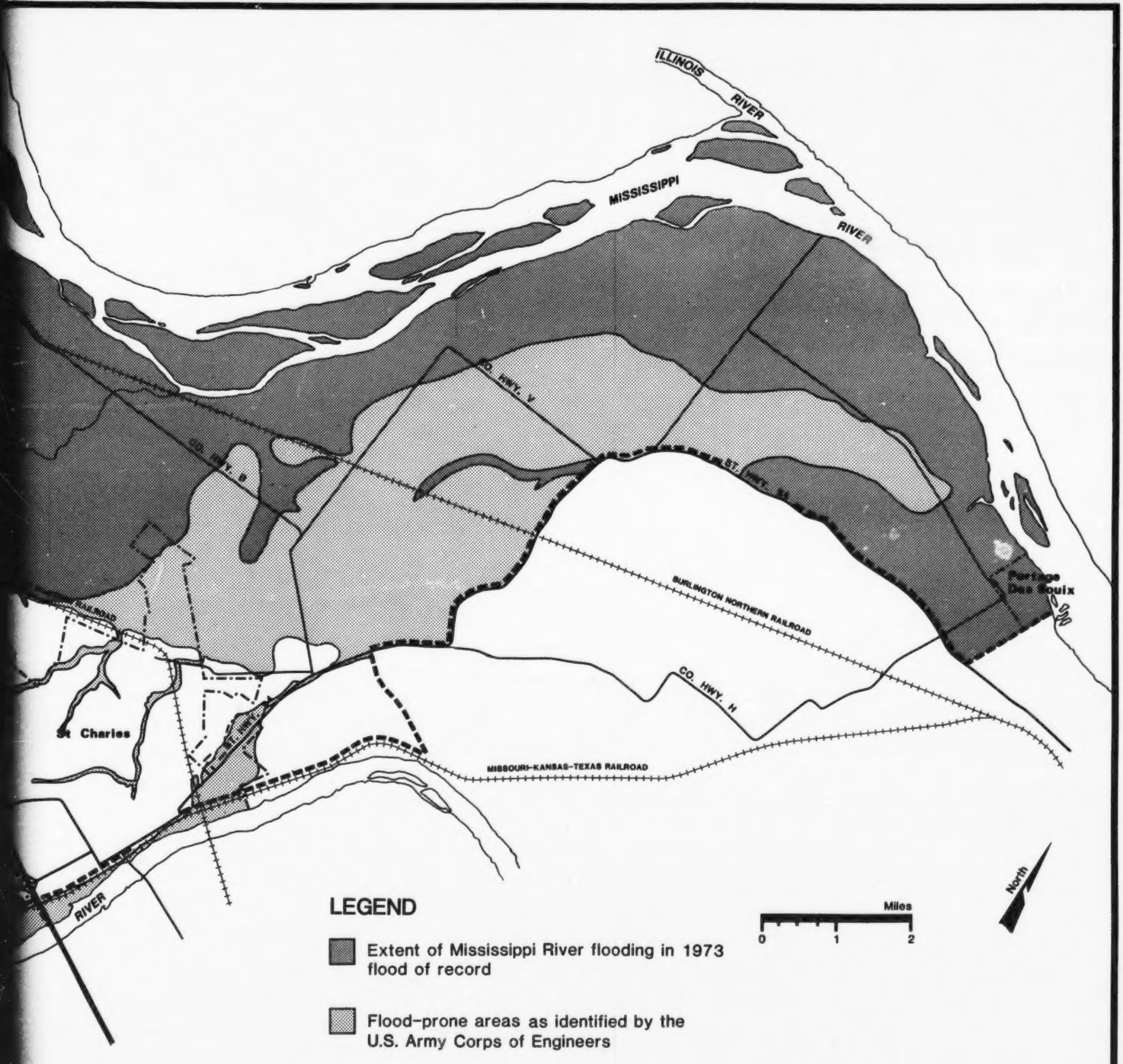

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
ST. HWY.
BURLINGTON NORTHERN RAILROAD
Portage Des Sioux
CO. HWY. H
St Charles
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
LEGEND
Extent of Mississippi River flooding in 1973 flood of record
Flood-prone areas as identified by the U.S. Army Corps of Engineers
Miles
0
1
2
North

Figure 3-6.

Flood-prone areas and Mississippi River flood of record.

Table 3-14 Elevations of 100-year floods on the Mississippi and Missouri rivers at the boundaries of the planning area.

River	River Mile	Elevation (ft msl)
Mississippi	212	439.2
Mississippi	231	443.3
Missouri	25	449.5
Missouri	44	467.5

Many tributary stream valleys of the Mississippi and Missouri rivers also are subject to flooding (Figure 1-6). The floodplains along the small creeks have varying amounts of residential development but could come under heavy pressure for new development. Increased potential for flood damages due to increased development in these floodplains will result unless mitigative actions are taken. The tributary streams in the planning area (Dardenne, Crooked, Schote, Spencer, Sandfort, Cole, Duckett, and Taylor) also provide storage volume for high water flows on the Missouri and Mississippi rivers. Increased development in the floodways of these streams will reduce that storage.

There are no USGS gaging stations maintained on tributaries of the Mississippi or Missouri rivers inside the planning area. However, the COE did perform flood studies for Dardenne Creek (including Schote Creek and Crooked Creek) and Spencer Creek. Because no stream-flow records were available, the COE estimated flood flow discharge frequencies for Dardenne Creek by empirical methods. For Spencer Creek, frequency curves developed by the USGS were used to select peak discharges for the 100-year flood.

St. Charles County has chosen to participate in the emergency provisions of the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA). The provisions of the National Flood Insurance Program require that owners seeking to improve property or buyers of property located in flood-hazard areas purchase insurance as a condition for obtaining mortgage loans from Federally-chartered or -insured lending institutions. For property owners to quality for Federally-subsidized flood insurance, a local government must adopt and enforce landuse controls which lessen or avoid damage in floodprone areas. St. Charles County has adopted a Floodplain Ordinance that complies with the requirements of the National Flood Insurance Program.

3.1.4. Biological Resources

3.1.4.1. Aquatic Communities

Habitats

The major aquatic habitats in the planning area include both lotic (running waters) and lentic (still waters) communities. The Mississippi River borders the northern edge of the planning area and the Missouri River extends along most of the southern edge. Numerous small creeks dissect the planning area generally from north to south. However, Dardenne Creek, the largest stream, runs in a northeasterly direction and finally enters the Mississippi River along the northern boundary of the planning area.

Two small lakes, Luesseville Lake and Graus Lake, occur at opposite ends of Marais Temps Clair in the eastern part of St. Charles County immediately adjacent to the planning area. Marais Temps Clair is an extensive shallow wetland that is discussed in Section 3.1.4.2. The physical and chemical characteristics of surface waters in the planning area are discussed in Section 3.1.3.1. A summary of data pertaining to the various aquatic habitats in the planning area is presented in Table 3-15.

Biota

Phytoplankton are the primary producers in the aquatic ecosystem. They are at the base of the food chain and are thus consumed by virtually all animals at higher trophic levels. Phytoplankton are dependent on sunlight for photosynthesis. Activities that limit the transmission of light through water or adversely alter water quality, significantly affect their existence.

Table 3-15. List of characteristic taxa of aquatic organisms known or expected to occur in aquatic habitats in the planning area.

Aquatic Habitats	Phytoplankton	Zooplankton	Macroinvertebrates	Fish
• Rivers and Backwaters	Diatoms	Rotifers	Oligochaetes	Common Carp
Mississippi River	Bacillariophyta	Keratella	Naididae	Catfish
Missouri River	Blue-Green Algae	Polyarthra	Tubificiadae	Buffalos
	Cyanophyta	Copepods	Diptera	Sunfish
	Green Algae	Cladocerans	Chaoborus	Black and White Crappie
	Chlorophyta	Bosmina	Chironomus	Largemouth Bass
			Rheotanytarsus	Bluegill
			Gastropods	
• Streams				
Dardenne Creek	Same as Above	Same as Above	Oligochaetes	Sunfish (small)
Crooked Creek			Tubificidae	Minnows
Spencer Creek			Dipterns	
Cole Creek			Chironomus	
Balleau Creek			Ephemeropterans	
Schote Creek			Caenis	
• Lakes and Ponds				
Mertz Lake	Green Algae	Cladocerans	Oligochaetes	Sunfish
Luesseville Lake	Chlorophyta	Daphnia	Tubificidae	Black and White Crappie
Graus Lake		Rotifers	Dipterans	Largemouth Bass
Ponds		Gastroupus	Chironomus	Bluegill
		Copepods	Ephemeropterans	Catfish
			Hexagenia	Channel Catfish

Limited information is available concerning phytoplankton abundance and distribution in the immediate planning area. However, phytoplakton are expected to be of less importance due to the high levels of turbidity in area streams. Diatoms are generally considered to be the most important constituent of slow flowing rivers and streams, since more silicon is available in the more turbulent systems. However, Galtsoff (1924) found Chlorophytes and blue-green algae to be more abundant in the upper Mississippi River than diatoms. Reinhard (1931) however, collected some 115 taxa of phytoplankton and found diatoms to be by far the most abundant photoplankton in the Mississippi River. Names of some of the phytoplankton taxa that should be commonly associated with aquatic habitats in the planning area are listed in Table 3-15.

Zooplankton, like phytoplankton, are at the base of the food chain in the aquatic ecosystem. Zooplankton feed on phytoplankton and on detritis, and in turn are eaten by larger forms, especially insect larvae and juvenile fish. Reinhard (1931) found 73 taxa of zooplankton in his survey of the upper Mississippi River, with rotifers being most abundant. Copepods and Cladocerans should also be a well represented because all three are considered typical of running waters (Whitton 1975). Names of some of the characteristic zooplankton taxa that occur in aquatic habitats in the planning area are included in Table 3-15.

Macroinvertebrates are comprised of a variety of aquatic forms that vary in size from microscopic insect larvae to those that commonly reach lengths of 6 inches such as crayfish. Exclusive of microscopic forms, insects and mollusks compose as much as 70% of the macroinvertebrate population (Welsh 1952). These two groups generally live in or immediately above the bottom sediments and are the most important macroinvertebrates in the planning area. Names of some of the characteristic macroinvertebrates that occur in aquatic habitats in the planning area are listed in Table 3-15.

Fish, as primary consumers in the aquatic community, depend on lower trophic levels. As a primary consumer, they are susceptible to contamination that can occur through food chain bioaccumulation, direct changes in water quality such as increased toxic elements, lowered dissolved oxygen concentrations, sudden or extreme changes in temperature or pH, and elimination of lower food chain organisms. Distributional data on the fishes of Missouri were reported by Pflieger (1971, 1975).

Names of some of the more common species of predominantly warm water fish that occur in planning area habitats are included in Table 3-15. Sunfish and catfish are among the most common and important. Virtually all streams and lakes in the planning area contain populations of these two groups of fishes. A more detailed description of the fishery resources in the planning area is contained in the following section.

Important Habitats and Species

Recreationally or Commercially Important Habitat and Species -- The Mississippi River is a productive fishery. Commercial catches from Pool 26 during 1979 included 12,155 pounds of common carp (*Cyprinus carpio*), 10,759 pounds of buffalo (*Ictiobus* spp.), and 7,796 pounds of catfish (*Ictalurus* spp. and *Pylodictic olivaris*) (Missouri Department of Conservation 1980).

Recreational fishing also occurs along the Mississippi and Missouri rivers and associated backwaters. Brickhouse Slough and Deep Slough on the Mississippi River are among the better crappie (*Pomoxis* spp.) and largemouth bass (*Micropterus salmoides*) fishing areas. Small lakes and ponds also provide good fishing for catfish and sunfish in the planning area.

Endangered, Threatened, or Rare Species -- No Federally-listed endangered or threatened aquatic species frequent the planning area. One mussel and seven fish species listed by the state as rare or endangered are known to occur or have occurred in the Mississippi River, Missouri River, or adjacent waters in the planning area. The names and status of state-listed species are presented in Table 3-16.

3.1.4.2 Terrestrial Communities

Land Cover Types

Due to the proximity of the planning area to the Mississippi River and Missouri River floodplains, land cover over much of the northern half of the planning area exists predominantly as nonforested bottomlands. However, the southern half of the planning area approximately south of I-70, conforms to Bailey's (1980) description of the Oak-Hickory Section of the Eastern Deciduous Forest Province, which generally extends from western Tennessee and Ken-

Table 3-16. List of rare or endangered aquatic species that occur or have been reported from St. Charles County (Missouri Department of Conservation, nd).

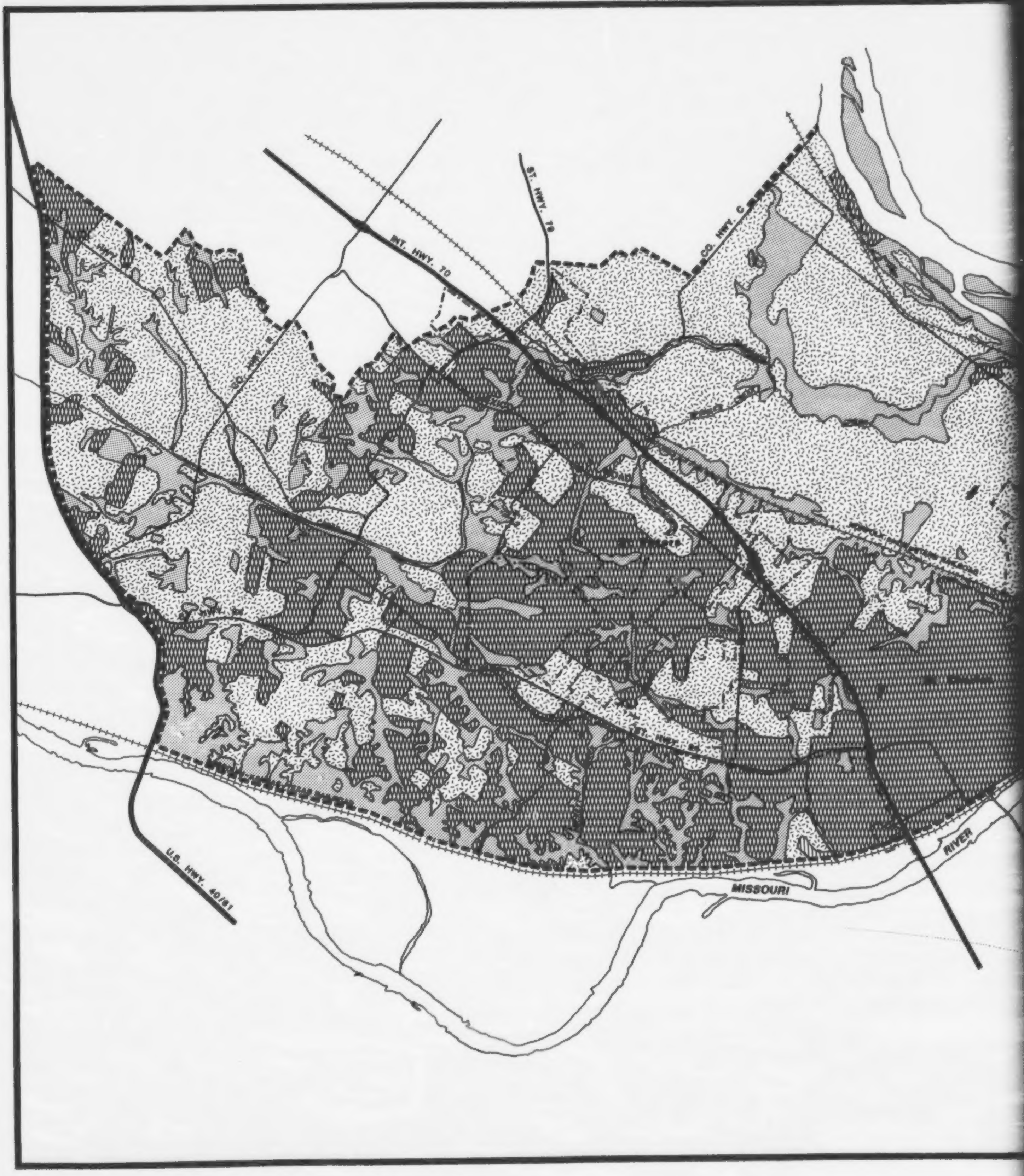
Mussels-Common Name	Scientific Name	Status
Pond-horn	Uniomerus tetralasmus	Rare
Fishes-Common Name	**Scientific Name**	**Status**
Lake Sturgeon	Acipenser fulvescens	Endangered
Pallid Sturgeon	Scaphirhynchus albus	Endangered
Alabama Shad	Alosa alabamae	Rare
Sturgeon Chub	Hybopsis gelida	Rare
Sicklefish Chub	Hybopsis meeki	Rare
Pallid Shiner	Notropis amnis	Possibly Extirpated
Burbot	Lota lota	Rare

tucky throughout most of southern Missouri and northwestern Arkansas.

Four major terrestrial land cover types (forest, agricultural, wetlands, urban/residential) were delineated from recent aerial photographs of the planning area (Figure 3-7). Although some overlap of plant and animal species occurs among all land cover types, a different assemblage of plant and animal species generally can be associated with each cover type (Table 3-17).

Forested Lands

Two distinct forest communities, the bottomland forest and upland forest, occur in the planning area. The bottomland forest type occurs along the floodplain of the Mississippi River and Missouri River, and along low-lying sections of major tributary streams (e.g., Dardenne Creek, etc.) to these rivers. Commonly associated tree species include silver maple (Acer saccharium), cottonwood (Populus deltoides), sugar berry (Celtis laevigata), white willow (Salix alba), and sandbar willow (S. interior). Some less common tree species include: river birch (Betula nigra), black walnut (Juglans nigra), pecan (Carya illinoensis), and red mulberry (Morus rubra). The shrub dominated understory, although generally open due to periodic flooding, contains a variety of herbaceous species such as poison ivy (Rhus radicans) and false grape (Ampelopis cordata).


INT. HWY. 70
ST. HWY. 79
CO. HWY. C
U.S. HWY. 40/61
MISSOURI
RIVER

3-51.a

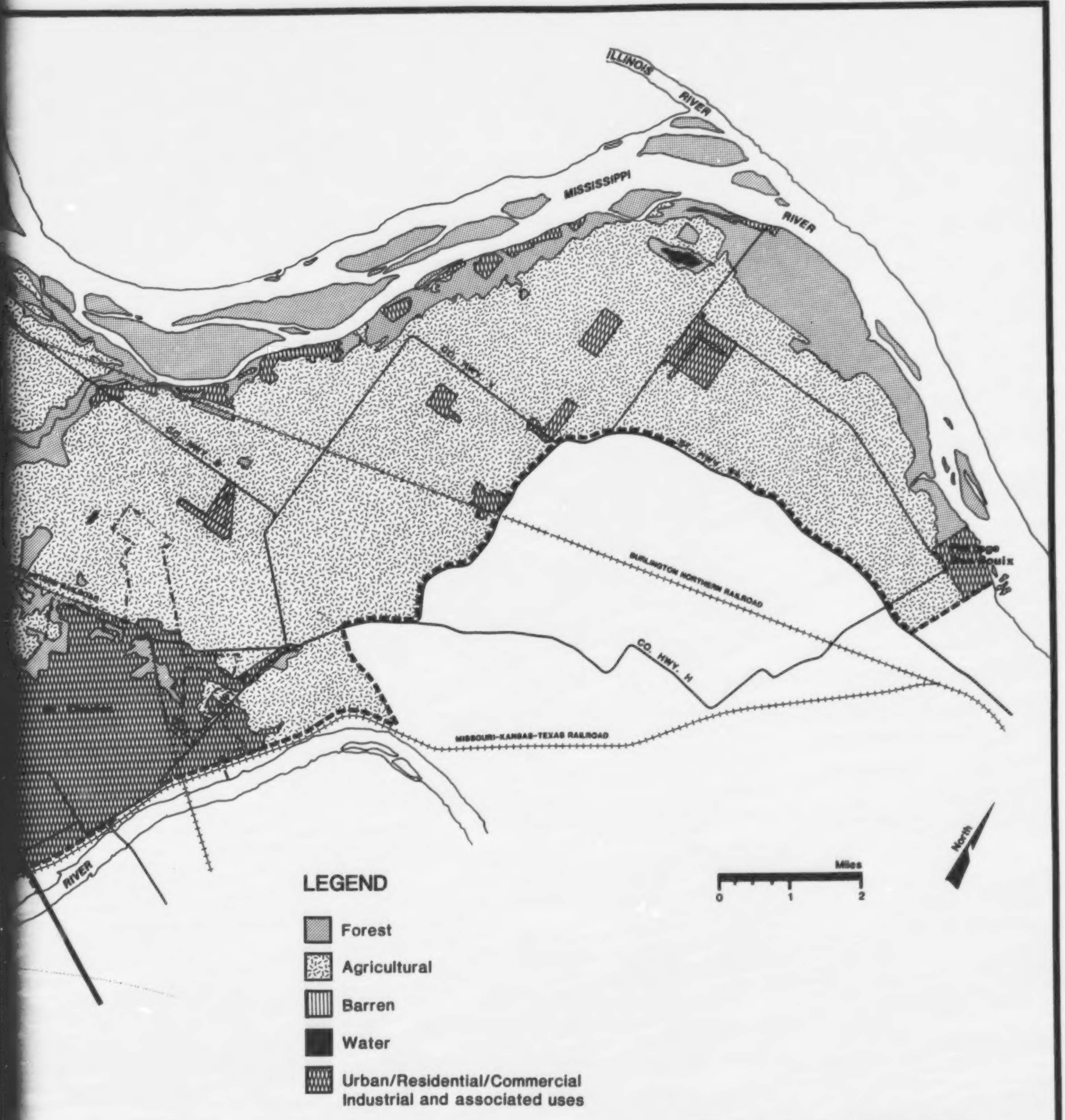

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
CO. HWY. 94
BURLINGTON NORTHERN RAILROAD
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
North
Miles
0
1
2
LEGEND
Forest
Agricultural
Barren
Water
Urban/Residential/Commercial Industrial and associated uses

Figure 3-7. Land cover.

Table 3-17. Representative plant and animal species in the four major land cover types in the planning area.

Land Cover/ Habitat	Plants[1]	Amphibians and Reptiles[2]	Birds[3]	Mammals[4]
Forested	Silver Maple Cottonwood Sugar Berry White Willow Red Oak Black Oak Red Cedar Poison Ivy	American Toad Eastern Box Turtle Five-lined Skink Red Milksnake	Great-horned Owl Screech Owl Common Flicker Red-headed Woodpecker Downy Woodpecker Tufted Titmouse Wood Thrush Nashville Warbler Scarlet Tanager Cardinal Blue Jay	Virginia Opossum Least Shrew Gray Squirrel Fox Squirrel White-footed Mouse White-tailed Deer
Agriculture	Corn Soybean Wheat Sorghum	Southern Leopard Frog Eastern Yellow-bellied Racer	Sparrow Hawk Bobwhite Mourning Dove Ring-necked Pheasant Mallard Killdeer Meadow Lark Cowbird	Striped Skunk Eastern Cottontail Rabbit Coyote
Wetlands	Bulrushes Sedges Spike Rushes	Blanchards' Cricket Frog Upland Chorus Frog Bullfrog Eastern Box Turtle Eastern Ribbon Snake Diamondback Water Snake Midland Water Snake	Marsh Hawk Bald Eagle Great Blue Heron Mallard Pintail Wigeon Wilson's Snipe Red-winged Blackbird	Raccoon Muskrat Mink

Table 3-17. Representative plant and animal species in the four major land cover types in the planning area (concluded).

Land Cover/ Habitat	Plants[1]	Amphibians and Reptiles[2]	Birds[3]	Mammals[4]
Urban/ Residential	Cultivated Trees and Shrubs-Lawns Fruit Trees Silver Maple Red Oak Black Oak	American Toad Eastern Box Turtle Eastern Garter Snake	Screech Owl Mourning Dove Ruby-throated Hummingbird Purple Martin Blue Jay Mockingbird Robin Starling House Sparrow	Virginia Opossum Fox Squirrel Gray Squirrel Eastern Cottontail Rabbit

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[1] Missouri Department of Conservation 1980.

[2] Smith 1961.

[3] Missouri Department of Conservation nd.

[4] Schwartz and Schwartz 1969.

The upland forest areas occur on elevated lands on and along ridges where slope has precluded conversion of lands to agricultural or urban uses. Common overstory plant species typical of this area include oaks such as northern red oak (*Quercus rubra*), black oak (*Q. velutina*), and white oak (*Q. alba*), the eastern red cedar (*Juniperus virginiana*) and several species of hickories (*Carya* spp.). The ground in upland areas is generally covered with a thick leaf layer and the understory is sparsely vegetated with saplings of the common tree species listed above.

Wetlands

Wetlands occur predominantly in the northern half of the planning area in the Mississippi River and Missouri River floodplains (Figure 3-7). More acreage of wetlands once occurred along the Mississippi River, but agricultural land uses have resulted in extensive wetland drainage and conversion programs.

Typical wetlands in the planning area consist of emergent palustrine wetlands made up of bulrushes (*Scirpus* spp.), sedges (*Carex* spp.), and spike rushes (*Eleocharis* spp.). These areas are extremely valuable to a diversity of wildlife in the planning area, especially furbearers and waterfowl.

Agricultural Land

Vast acreages of the once mesic and wet-mesic prairies that occurred along the Mississippi River and Missouri River have been converted to agricultural uses. The 926-acre Marais Temps Clair Wildlife Management Area, between State Highway 94 and Route H just east of the planning area, is the only large site in the vicinity of the planning area containing remnant prairie vegetation.

Several crops such as wheat (*Tridens flavus*), sorghum (*Sorghum valgare*), and soybean (*Glycine max*), are grown extensively in lowland areas. Corn (*Zea mays*) also is grown in lowland areas, but is more commonly grown in well drained soils at higher elevations in the planning area. These crops provide food for a variety of wildlife species, especially birds (Martin et al. 1951).

Minimal acreages of pasture and abandoned cropland occur in the planning area. Due to the physical similarity between pasture and abandoned cropland, and agricultural land, no differentiation was attempted in Figure 3-7.

Urban Residential

Much of the southern half of the planning area is contained within an extensive urban/residential complex (Figure 3-7). Many of the native plant species were cleared, or are being cleared. However, since trees are considered important both aesthetically and monetarily, a wide variety of native trees and shrub species were left by developers or replaced by homeowners. These native species, along with fruit trees and a diversity of cultivated shrubs, provide habitat for many less secretive species of wildlife (Table 3-17).

Wildlife

The wildlife habitats in the planning area closely correlate with land cover, as noted in Table 3-17. Many of the wildlife species whose names are listed adjacent to a particular land cover, occur in other land cover types. The listing only indicates the land cover (habitat) where a species might be expected to be found a majority of the time.

- Amphibians and Reptiles -- Since most amphibians and reptiles reproduce in or near water, habitats such as the bottomland forest and associated streams and wetlands are very important. Names of characteristic amphibian and reptile species that occur in the planning area are contained in Table 3-17.

- Birds -- Birds are among the most adaptable species of wildlife and occur in virtually all types of habitat. Some 364 species of birds have been observed in the state in recent years (Easterla and Anderson 1967). Because of the planning area's proximity to the Mississippi River (i.e., Mississippi migratory flyway), waterfowl are especially abundant. Names of some of the more common bird species that frequent habitats in the planning area are listed in Table 3-17.

- Mammals -- Mammals, like birds, are very adaptable, and also occur in virtually all habitat types. Some 70 species of mammals have been reported in Missouri; about 34 of these species have ranges that include the planning area (Schwartz and Schwartz 1969). Names of some of the more common species that frequent the planning area are listed in Table 3-17.

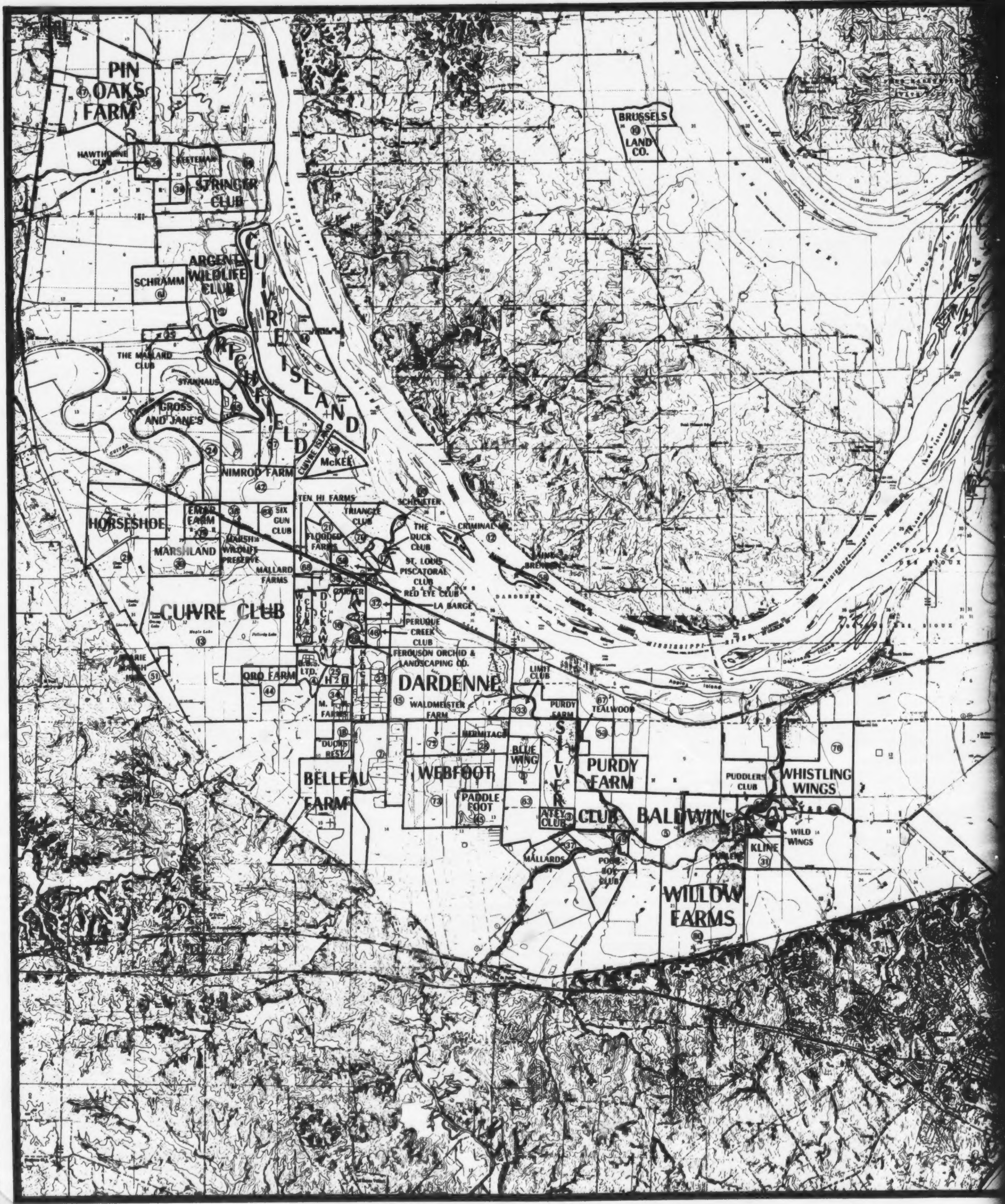
Important Habitats and Species

- Recreationally or Commercially Important Habitats and Species -- Although all land cover types in the planning area are important biologically, most of the agricultural lands and all wetlands in the northern half of the planning area along the Mississippi River and Missouri River floodplains are important commercial and recreational lands. Numerous hunting clubs have leased or purchased these lands to hunt upland game birds such as the Mourning Dove (Zenaida macroura), Bobwhite (Colinus virginianus), and Ring-necked Pheasant (Phasianus colchicus), as well as waterfowl. The locations and names of some of the larger hunting clubs are identified on Figure 3-8. Waterfowl hunting is by far the most extensive recreational use of land in the planning area (Personal communication, Mr. Shadfort, Missouri Department of Conservation, to WAPORA, Inc., February 1983). This is not surprising since some 5 to 9 million ducks migrate annually through or adjacent to the planning area (Bellrose 1976). Wetlands in the planning area also provide important habitat for furbearers such as the muskrat (Ondatria zibethicus). Annually, several thousand muskrat are trapped from wetlands in the planning area (Missouri Department of Conservation 1982).

Forested areas also are important and provide an outlet for recreation in rural sections of the planning area. This habitat provides opportunities for hunting turkey (Meleagris gallopavo), gray squirrel (Sciurus carolinensis), fox squirrel (S. niger), and white-tailed deer (Odocoileus virginianus) (MDNR nd).

- Endangered, Threatened, or Rare Species -- Although several Federally listed endangered species have ranges that include the planning area, the Bald Eagle (Haliaeetus leucocephalus) is the only Federally listed species that frequents habitats in the planning area. The Bald Eagle is a common winter resident in the northern half of the planning area along the Mississippi River (Personal communication, Mr. Shadford, Missouri Department of Conservation, to WAPORA, Inc., February 1983). Two individuals were sighted at the northwestern corner of the planning area during a site reconnaissance in January 1983. The Illinois Natural History Survey flies the Mississippi River weekly during the fall and winter months to observe and count waterfowl. Eight individual Bald Eagles were counted during their 6 December 1982 census in or near the planning area (Illinois Natural History Survey Data Files 1982). The Bald Eagle utilizes a variety of habitats near water. They generally roost and rest in the tallest tree near their feeding grounds. They are opportunistic feeders and will take a variety of vertebrate prey. However, when fish are available, they generally comprise a major part of the Bald Eagle's diet (US Fish and Wildlife Service 1980).

In addition to Federally listed species, a number of species are listed by the State of Missouri as being rare or endangered (Missouri Department of Conservation ND). Although the species on this list are not protected by a special law such as the Endangered Species Act (1973), they are considered important and special attention should be given to their preservation. The names and status of state listed species that potentially could occur in the planning area are included in Table 3-18.


PIN OAKS FARM
HAWTHORNE CLUB
STRINGER CLUB
BRUSSELS LAND CO.
SCHRAMM
ARGENT WILDLIFE CLUB
CUIVRE ISLAND
RICHFIELD
THE MALLARD CLUB
STANHAUS
GROSS AND JANE'S
NIMROD FARM
McKEE
TEN HI FARMS
SCHLUETER
TRIANGLE CLUB
SIX GUN CLUB
HORSESHOE
MARSH WILDLIFE PRESERVE
MARSHLAND
FLOODED FARMS
THE DUCK CLUB
CRIMINAL
ST. LOUIS PISCATORAL CLUB
RED EYE CLUB
LA BARGE
MALLARD FARMS
CUIVRE CLUB
DUCKAWAY
PERUQUE CREEK CLUB
FERGUSON ORCHID & LANDSCAPING CO.
DARDENNE
LIMIT CLUB
ORO FARM
H2O
WALDMEISTER FARM
PURDY FARM
TEALWOOD
DUCKS REST
HERMITAGE
BLUE WING
SILVER
BELLEAU FARM
WEBFOOT
PADDLE FOOT
PURDY FARM
PUDDLERS CLUB
WHISTLING WINGS
CLUB
BALDWIN
KLINE
WILD WINGS
MALLARDS
POOR BOY CLUB
WILLOW FARMS

3-57.a

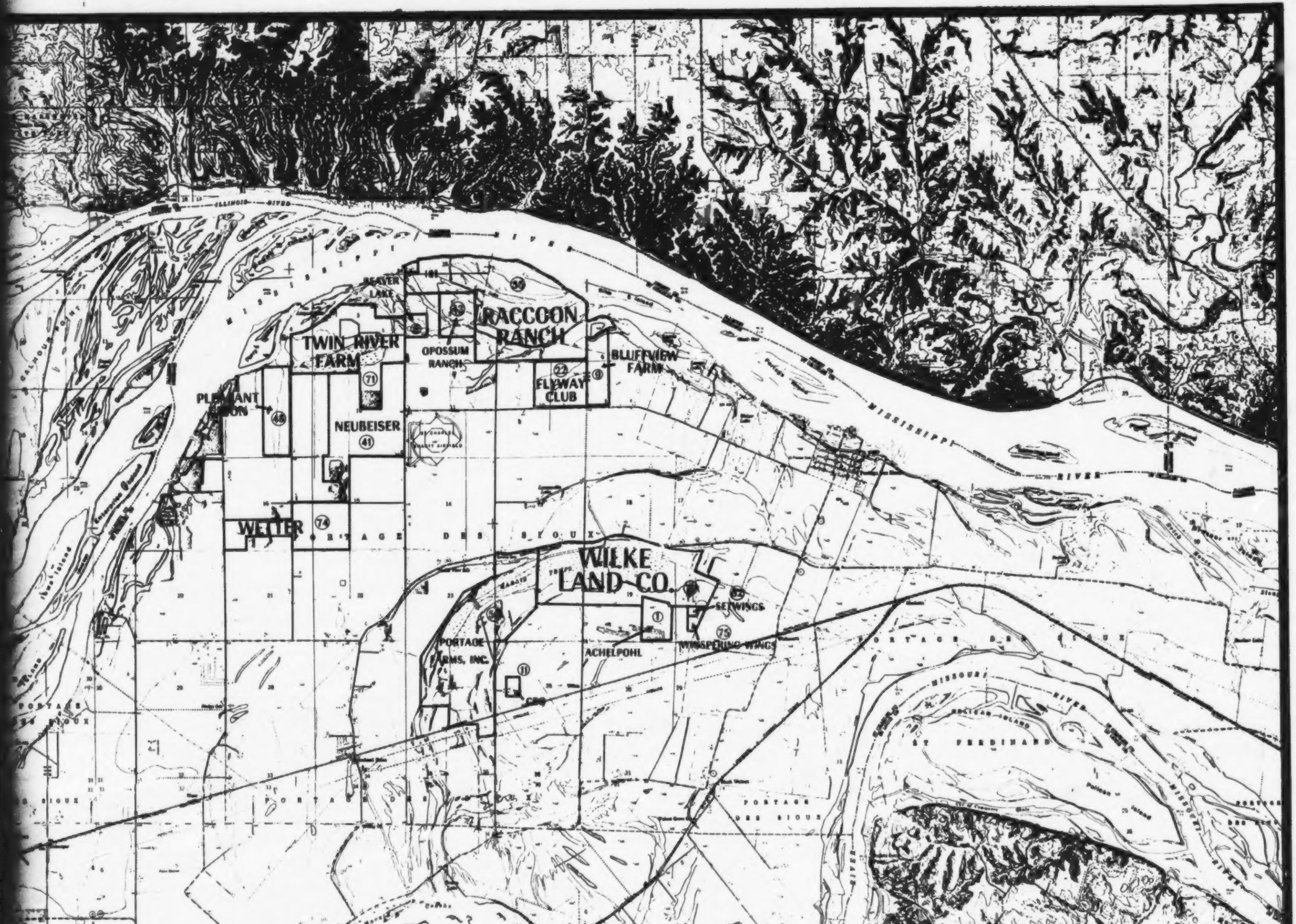

ILLINOIS RIVER
MISSISSIPPI RIVER
BEAVER LAKE
RACCOON RANCH
TWIN RIVER FARM
OPOSSUM RANCH
BLUFFVIEW FARM
FLYWAY CLUB
22
71
NEUBEISER
41
WETTER
74
PORTAGE DES SIOUX
WILKE LAND CO.
SETWINGS
WHISPERING WINGS
75
ACHELPOHL
PORTAGE FARMS, INC.
MISSOURI RIVER
ST FERDINAND
ST CHARLES

Figure 3-8. Duck clubs in St. Charles County and southern Lincoln County.

Source: Ducks Unlimited (1977).

Table 3-18. State listed rare and endangered species that potentially could occur in the planning area (Missouri Department of Conservation, nd).

PLANTS

Family	Scientific Name	Status
Asteraceae	*Boltonia asteroides* var. *decurrens*	Rare
Limnonthaceae	*Floerkea proserpinacoides*	Endangered
Lycoposiaceae	*Lycopodium lucidulum* var. *lucidulum*	Rare
Ophioglossaceae	*Ophioglossum vulgatum* var. *pycnostichum*	Rare
Araceae	*Peltandra virginica*	Rare

MAMMALS

Common Name	Scientific Name	Status
Long-tailed Weasel	*Mustela frenata*	Rare

AMPHIBIANS AND REPTILES

Common Name	Scientific Name	Status
Smooth Green Snake	*Opheodrys vernalis*	Rare
Massasauga	*Sistrurus catenatus*	Rare

BIRDS

Common Name	Scientific Name	Status
Red-shouldered Hawk	*Buteo lineatus*	Endangered
Ruffed Grouse	*Bonasa umbellus*	Rare
Sharp-shinned Hawk	*Accipiter striatus*	Endangered
Cooper's Hawk	*Accipiter cooperii*	Endangered
Upland Sandpiper	*Bartramia longicauda*	Rare
Swainson's Warbler	*Limnothlypis swainsonnii*	Rare
Henslow's Sparrow	*Ammodramus henslowii*	Rare

3.2 Manmade Environment

3.2.1. Land Use

3.2.1.1. Existing Land Use

The existing land use in the planning area is influenced primarily by natural features, i.e., floodplains, steep slopes and stream courses, and by transportation routes. The City of St. Charles was originally developed to take advantage of the transportation opportunities offered by the Missouri River, and by the railroads that extended across the county which linked the St. Louis area with the western plains. St. Peters also owes its original development to the railroads. The establishment of a railroad terminal in St. Peters in 1855 "helped influence the transition (of the community) from subsistence agriculture to commercial farming" (City of St. Peters 1982). The City of St. Charles' growth and land use exhibits the classic model of "concentric development" with a commercial center oriented toward an important transportation link, the Missouri River and the bridges that connect St. Louis and St. Charles counties, with decreasing densities outward from the center. As in many other cities, industrial uses developed adjacent to the commercial center and residential uses expanded outward as the population increased.

The major natural feature that affects land use in the planning area is the broad floodplain area of the Mississippi and Missouri rivers. The floodplain is demarcated by the steep bluff line that differentiates the upland portions of the planning area from the nearly level, lowland portions of the planning area. The bluff line also represents the boundary between urban development and the open space, agricultural uses of the floodplain. Within the upland areas, development also is limited in some areas by steep slopes that are present in the watersheds of the smaller tributary streams.

Existing land uses were inventoried (Table 3-19) and mapped (Figure 3-9) according to five general land use categories.

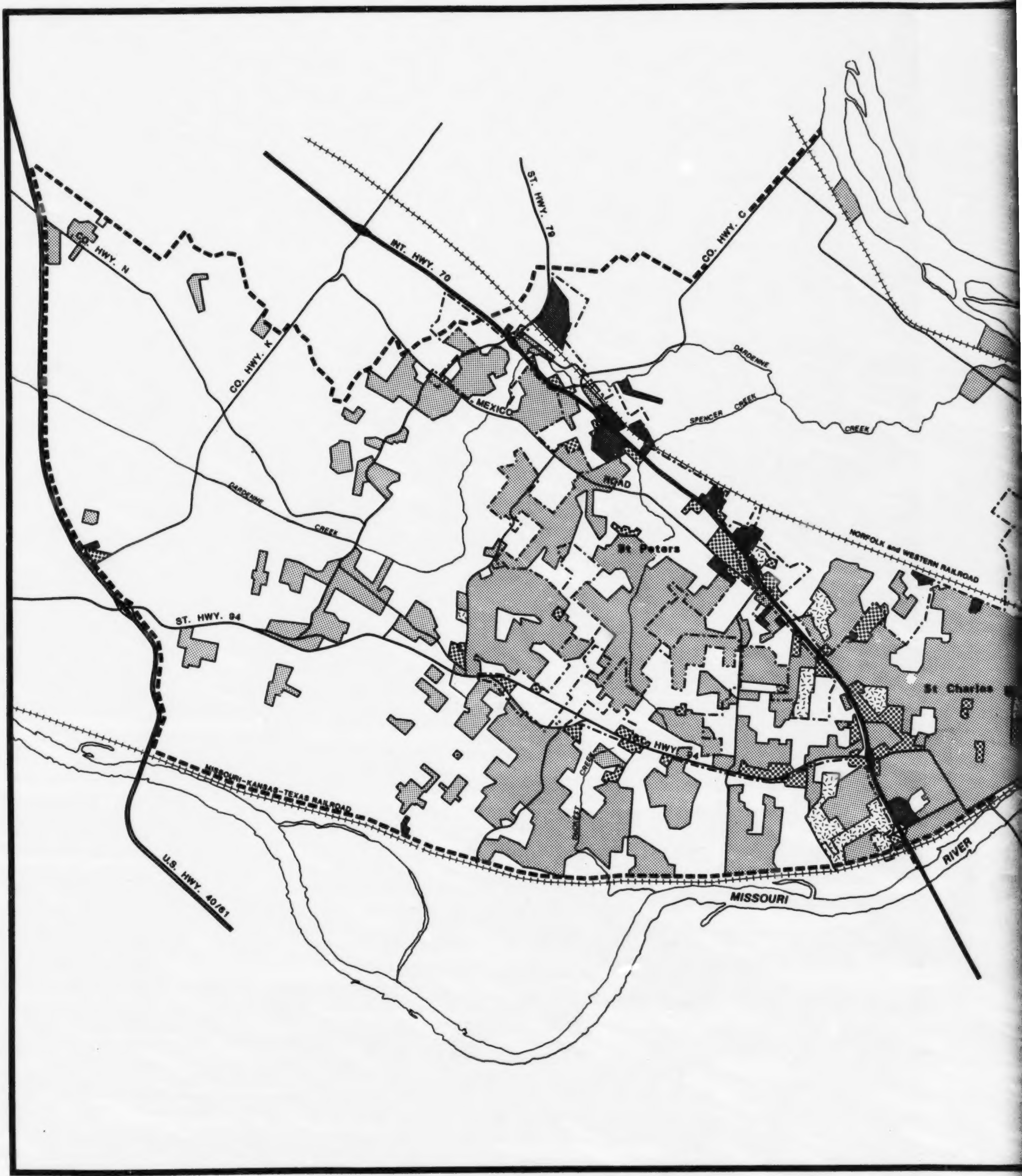
Table 3-19. Existing land use within the planning area (City of St. Charles nd; St. Peters 1982; East-West Gateway Coordinating Council [EWGCC] 1982).

Jurisdiction (Acres)	Non-Urbanized (Acres)	Residential (Acres)	Commercial (Acres)	Industrial (Acres)	Streets/ Parking Lots[1] (Acres)	Outdoor Recreation (Acres)
St. Charles	3,025	2,554	766	169	1,158	288
St. Peters	3,752	1,501	350	75	757	182
Golden Triangle[2] North	15,798	3,610	101	6	--	199
Golden Triangle[2] South	28,843	2,934	217	27	--	195
Northeast Planning Area[3]	43,697	961	278	36	--	84
Total	95,115	11,560	1,712	313	1,915	948
Percent (%)	85.3	10.4	1.5	0.3	1.7	0.9
Minus Northeast Planning Area	51,418	10,599	1,434	277	1,915	864
Percent (%)	77.3	15.9	2.2	0.4	2.9	1.3

[1] The number of acres in streets and parking lots was not calculated separately for the Golden Triangle and Northeast Planning Areas. In general, streets and parking lots typically account for approximately 20% of the land in urban areas.

[2] The Golden Triangle refers to the area bounded by the Missouri River, Highway 40-61, and I-70 and the Norfolk and Western Railroad. Highway 94 and County Route N represent the boundary between the Golden Triangle North and South Planning Areas. Land use acreages within the planning areas are for unincorporated areas only.

[3] The Northeast Planning Area encompasses the area between the Mississippi and Missouri rivers north of the Norfolk and Western Railroad and east of Highway 79. Land use acreages within the planning area are for unincorporated areas only.


CO. HWY. N
CO. HWY. K
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
MEXICO
DARDENNE
SPENCER CREEK
CREEK
ROAD
DARDENNE
CREEK
St Peters
NORFOLK and WESTERN RAILROAD
ST. HWY. 94
St Charles
ST. HWY. 94
CREEK
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
MISSOURI
RIVER

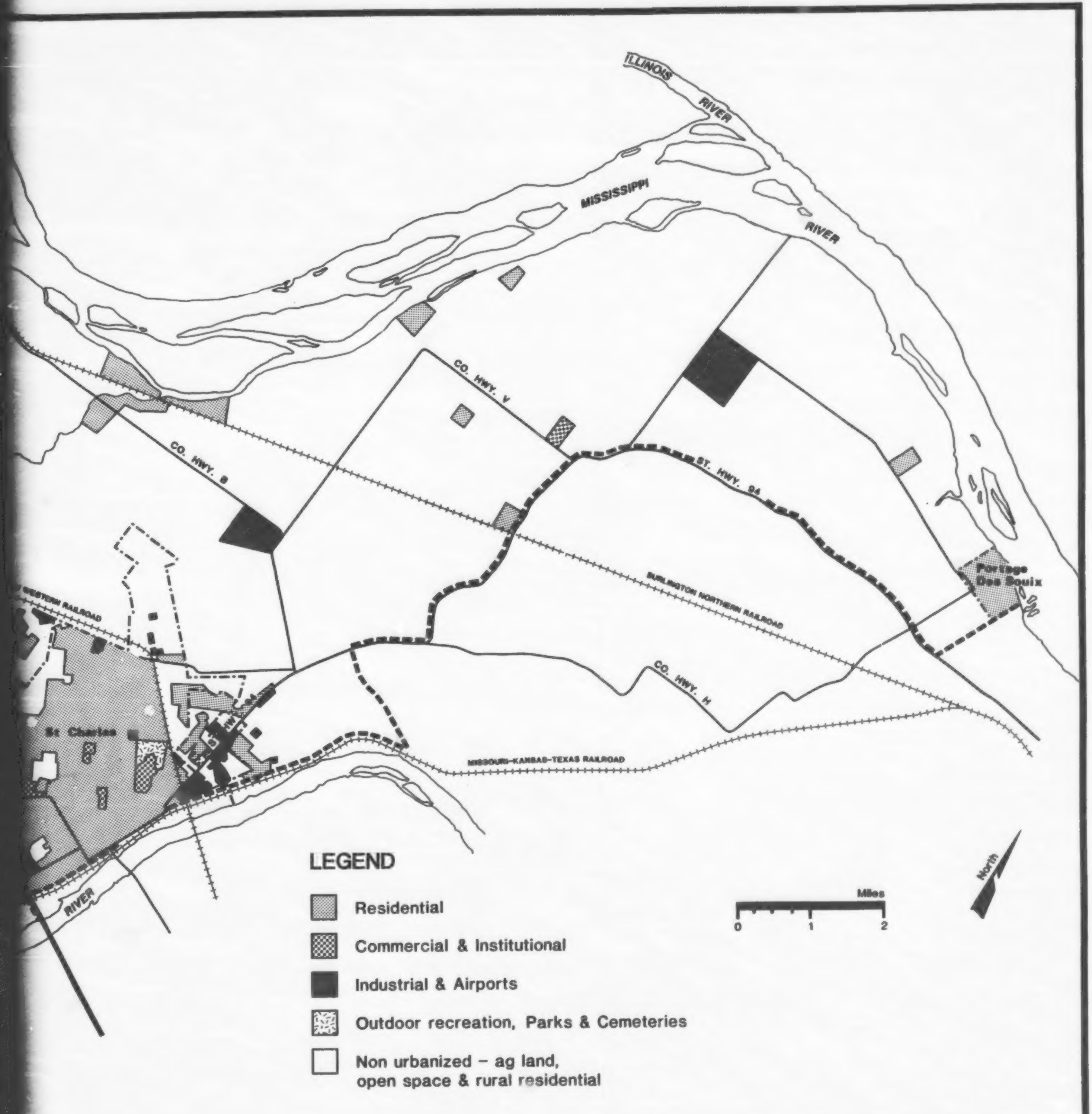

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
WESTERN RAILROAD
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
St Charles
Portage Des Souix
RIVER
LEGEND
Residential
Commercial & Institutional
Industrial & Airports
Outdoor recreation, Parks & Cemeteries
Non urbanized - ag land, open space & rural residential
Miles
0
1
2
North

Figure 3-9. Existing land use.

Non-Urbanized Land

This category includes agricultural and/or floodplain areas as well as other open spaces, forest lands, wetlands, and open water. These land uses account for the majority of the land within the planning area. Together, they comprise 85% of the planning area.

Although a large part of this acreage is in the floodplain portion of the planning area, a significant amount of the upland area also is in non-urbanized land uses. If the acreage in the Northeast planning area is not included, approximately 77.3% of the remaining portion of the planning area is in non-urbanized land uses (this includes essentially all of the area within the service areas of the cities of St. Charles, St. Peters and the Duckett Creek Sewer District).

Residential

This category includes high/medium density residential areas, low-density residential developments and mobile home parks. Approximately 11,560 acres or 10.4% of the planning area currently is in residential use. As Figure 3-9 indicates, residential development is concentrated in the City of St. Charles and dispersed throughout the remainder of the upland portion of the planning area in medium to large subdivisions. Residential use in the floodplain portion of the planning area occurs at very low densities, i.e. less than one unit per acre, and typically in conjunction with farm operations. If the Northeast planning area is excluded, residential land uses account for 15.9% of the remaining portion of the planning area. (Because of the map scales that were used, rural residential development, i.e., development less than one dwelling per half acre, could not be depicted on Figure 3-9.)

Commercial

This category includes Central Business Districts (CBDs) and commercial, service-oriented, and institutional (public and semi-public) land uses. Commercial uses are concentrated in the St. Charles CBD, adjacent to I-70, and adjacent to Highway 94 south of I-70. Approximately 1,712 acres or 1.5% of the planning area is in commercial use. If the Northeast planning area is excluded, commercial uses account for 2.2% of the remaining portion of the planning area.

Industrial

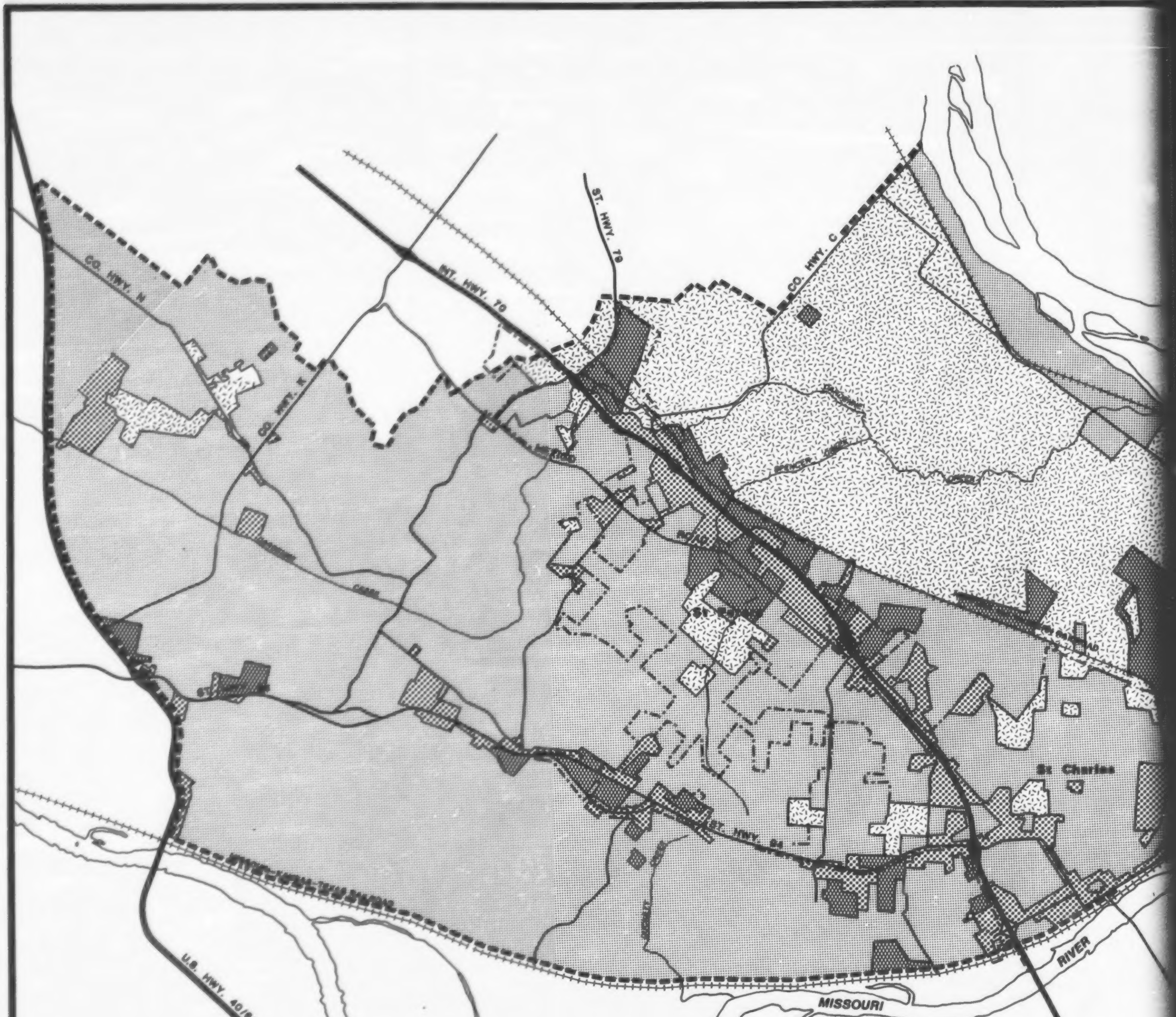
This category includes light and heavy industrial uses, utility facilities, and quarry operations. The greatest amount of industrial land is in the City of St. Charles; 169 of the 313 acres in industrial use are located in that city. Industrial land uses account for 0.3% of the total planning area and 0.4% if the Northeast planning area is excluded.

Outdoor Recreation This category includes parks, golf courses and cemeteries. Recreational land uses account for 948 acres or 0.9% of the planning area. Recreational lands are distributed throughout the planning area, although they primarily are situated adjacent to residential areas. If the Northeast planning area is excluded, recreational land uses account for 1.3% of the remaining portion of the planning area.

As Table 3-19 and Figure 3-9 indicate, the planning area contains a large amount of vacant land that is available for development. The "Golden Triangle," the area bordered by Highway 94, Highway 40-61, and the Norfolk and Western Railroad is projected to account for a substantial proportion of the growth estimated for St. Charles County (Section 3.2.3.). The amount of vacant land available within the service areas of the cities of St. Charles and St. Peters, and the Duckett Creek Sewer District can easily accommodate the projected growth. Thus, the future development of land within these areas for residential or commercial use primarily will be a function of transportation access, infrastructure capacity (i.e., schools, hospitals, and other public services), land costs, and the absence of developmental constraints (i.e., steep slopes, floodplains, etc.).

3.2.1.2. Development Controls

Land use within the planning area is regulated by St. Charles County, and the cities of St. Charles, St. Peters, and Portage Des Sioux. Zoning and subdivision ordinances are the means of land use regulation used. The majority of the upland portion of the planning area is zoned for residential use while the floodplain portion primarily is in floodplain zoning as required by the National Flood Insurance Program (Section 3.1.3.3.). Zoning designations in the planning area are depicted in generalized fashion in Figure 3-10.


CO. HWY. N
CO. HWY. K
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
CREEK
ST. HWY. 94
St Charles
U.S. HWY. 40/61
MISSOURI
RIVER

3-64.a

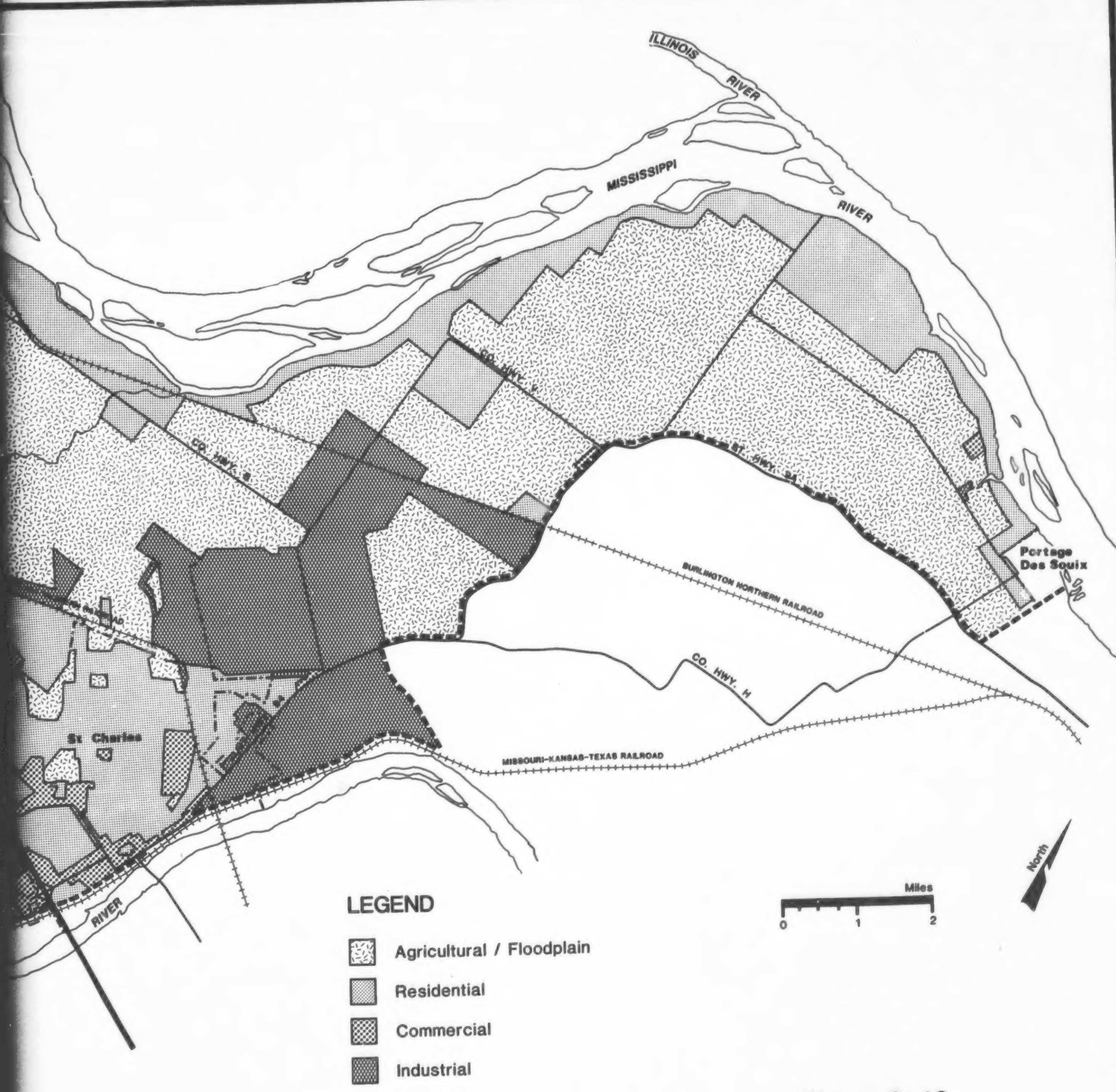

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
CO. HWY. H
MISSOURI-KANSAS-TEXAS RAILROAD
St Charles
Portage Des Souix
RIVER
Miles
0
1
2
North
LEGEND
Agricultural / Floodplain
Residential
Commercial
Industrial

Figure 3-10.
Zoning classifications.

3.2.1.3. Projected Land Use

EWGCC has developed land use projections for the year 2000 for the Golden Triangle North and South planning areas and the Northeast planning area. St. Peters, in its recently prepared Comprehensive Plan (1982), has developed land use allocations through 1990 for its planning area. Although the City of St. Charles has not updated its 1974 Comprehensive Plan, land use data for its planning area are available and provide an indication of future land use within the City. Future land use is discussed below for the planning areas and the two cities.

Golden Triangle

The Golden Triangle (both North and South planning areas) includes land that is within the service areas of the cities of St. Charles and St. Peters, and the Duckett Creek Sewer District. It is not possible to differentiate between future land use within the three service areas. The EWGCC land use projections apply to areas that currently are unincorporated. The Draft Unincorporated St. Charles County Land Use Plan (EWGCC 1982) indicates, however, that "...as annexations have been a factor in the incorporated/unincorporated county population distribution in the past, they will continue to be so in the future."

According to the Draft Land Use Plan, residential land use in the Golden Triangle will increase from 6,543 acres in 1980 to 11,793 acres in the year 2000. As noted above, this residential land will be distributed in each of the three service areas. Commercial land use is estimated to account for 852 acres in the year 2000 as compared to the 242 acres of commercial land (excluding public and institutional uses) in 1980. Industrial uses accounted for 33 acres in 1980; by the year 2000, industrial land use is estimated to account for 163 acres within the unincorporated portion of the Golden Triangle.

City of St. Peters

Although St. Peters' planning area includes a substantial amount of land outside its existing city limits, the City's 1990 land use allocations provide an indication of the City's intended distribution of land within its planning area. (In 1980, there were 6,617 acres within St. Peters' city limits; the City's planning area encompasses 10,275 acres.) The City has allocated 6,619 acres of land within its planning area for residential use, 1,422 for commercial use, and 1,392 for industrial use (St. Peters 1982). The City's Comprehensive Plan states:

> Most residential growth will occur in undeveloped areas within the Spencer Creek and Dardenne Creek watersheds. As the City continues to "square-off" its boundaries in these watersheds, it is anticipated that other residential areas, some already developed, will be added to the City's corporate limits.
>
> As might be expected, the (Land Use) Map anticipates most commercial growth to occur within the I-70 and Missouri Highway 94 corridors. Specifically, the most extensive activity is between the Cave Springs and Highway C interchanges which encompass the May Company's Mid Rivers Mall development.
>
> The Land Use Map provides for additional industrial growth concentrated in a few defined areas rather than scattered throughout the City. The most extensive of these industrial areas is in the northwest portion of the City, called Arrowhead Industrial Park. Because of its available rail access, the Arrowhead area can accommodate both light and heavy industrial uses. The remaining planned industrial areas, i.e., Cherokee, I-70 Industrial and St. Peters Industrial Parks, are partially developed but can accommodate some industrial expansion.

City of St. Charles

Within the City of St. Charles' planning area, there are 4,390 acres of residential land and 16,060 acres of vacant land (City of St. Charles nd.). The City's 1974 Comprehensive Plan (Harland Bartholomew and Associates 1974) indicates that the current pattern of land use will be maintained in the future. The existing developed areas, including the CBD and highway commercial uses along I-70, will be maintained, and the majority of the future development will be in the area south of I-70. This area is planned for low density residential developed (5 units per acre or less) with neighborhood commercial centers along Highway 94, and at the intersection of the major collector roadways (e.g., Country Club Road and Muegge Road, Horstmeier Road and Country Club Road).

Northeast Planning Area

The Northeast Planning Area includes the floodplain area north of the Norfolk and Western Railroad and east of County Highway C. The easternmost portion of the Northeast Planning Area, including the community of West Alton, is outside the boundaries of the facilities planning area. Because of the constraints to development posed by the periodic flooding that occurs in this area, the EWGCC (1982) estimated little increase in the amount of land in urban land uses. Residential land is estimated to account for 2,378 acres in the year 2000 as compared to the 1,632 acres of residential land in this area in 1980. There currently are 207 acres of industrial land in this area; no additional industrial land is projected for the Northeast Planning Area (EWGCC 1982).

The area that is of most concern for this project, the Golden Triangle, contains two cities and the Duckett Creek Sewer District. Because the available land use information for this area does not uniformally apply to the entire area, it is difficult to allocate future land use within the planning area to correspond to the population projections (Section 3.2.2.3.). However, it is apparent that the amount of vacant land available for development exceeds the requirements of the projected population growth, and the planning policies in effect for the area, as embodied in the zoning classifications, support the continued urbanization of the Golden Triangle. As additional development occurs, it will be necessary to coordinate planning policies and infrastructure improvement programs on a local, county, and regional basis to ensure the orderly and efficient provision of necessary public facilities and services.

3.2.2. Demographics

3.2.2.1. Historic Population Trends

Both the City of St. Charles and St. Charles County have experienced continuous population growth since 1920 (Table 3-20). Although St. Peters experienced erratic growth between 1920 and 1970, a combination of extensive annexations and residential development resulted in an increase in the City's population from 486 in 1970 to 15,700 in 1980 (US Department of Commerce 1982). The growth rate in St. Charles County has been extremely high for the past three decades and even though the rate (percent increase) was highest in the decade from 1950 to 1960, and has since declined (Table 3-21), the absolute population increase in each decade since 1950 has exceeded that of the previous decade. The County's population grew by 23,136 persons during the 1950s, by 39,984 persons during the 1960s, and by 51,153 persons during the 1970s. St. Charles County had both the highest growth rate and the greatest absolute population increase between 1970 and 1980 of the eight counties that comprise the St. Louis metropolitan area. Although the City of St. Charles also has experienced high growth rates since 1950, the growth rate declined sharply during the 1970s, as compared to the City's growth rates during the 1950s and 1960s.

There are two components of population change--natural increase (or decrease), which refers to the number of births and deaths recorded in an area over time; and migration, the movement of people into or out of the area. Thus, population change from one year to the next derives from the addition of new residents through births or in-migration and the substraction of existing residents through deaths and out-migration.

Table 3-20. Historic population growth in the planning area between 1920 and 1980 (EWGCC 1982).

Year	St. Charles County	Unincorporated St. Charles County	St. Charles City	St. Peters	St. Louis SMSA[1]	Missouri
1920	27,828	12,319	8,503	358	--	3,404,055
1930	24,354	11,945	10,491	248	--	3,629,367
1940	25,562	12,578	10,803	305	--	3,784,664
1950	29,834	12,645	14,314	377	--	3,954,653
1960	52,970	24,288	21,189	404	--	4,319,813
1970	92,954	48,625	31,834	486	2,410,884	4,676,501
1980	144,107	72,956	37,379	15,700	2,356,460	4,916,686

---

[1] Standard Metropolitan Statistical Area (SMSA)
Dashes (--) indicate that data are unavailable.

Table 3-21. Percent change in the population of the planning area between 1920 and 1980 (EWGCC 1982).

Time Period	St. Charles County	Unincorporated St. Charles County	St. Charles City	St. Peters	St. Louis SMSA	Missouri
1920-1930	6.7	-3.0	23.4	-30.7	--	6.6
1930-1940	5.0	5.3	3.0	23.0	--	4.3
1940-1950	16.7	0.5	32.5	23.6	--	4.5
1950-1960	77.5	92.1	48.0	7.2	--	9.2
1960-1970	75.5	100.2	50.2	20.3	--	8.3
1970-1980	55.0	50.0	17.4	3,130.5	-2.3	5.1

Dashes (--) indicate that data are unavailable.

The population increases experienced in St. Charles County and the two planning area cities between 1970 and 1980 primarily are the result of in-migration; 70.9% (36,289 persons) of St. Charles County's population increase was due to net in-migration while natural increase (births over deaths) accounted for the remaining 29.1% (14,864 persons; EWGCC 1982). According to a 1982 study by EWGCC on "Intra-Regional Migration in the St. Louis Metropolitan Area," the zip code area in the county "receiving the largest amount of family and individual migration was St. Peters, accounting for about 49.2% of the county's total." The St. Charles/Harvester area accounted for the next largest number of moves with 27.2% of the County total. In addition, the same study found that some movement within St. Charles County also had occurred, primarily from the St. Charles City zip code areas to the St. Peters-O'Fallon zip code areas and to rural zip code areas in the western part of the county.

The increasing attraction of this area for residential development is further borne out by information from the 1980 Census on housing age. Nearly half (49.0%) of the year-round housing units in St. Charles County were constructed from 1970 to March 1980 (US Department of Commerce 1982). In St.

Peters, the amount of new residential construction in the last decade is even more significant; 93.5% of that City's 5,286 housing units were built from 1970 to March 1980. In the City of St. Charles, 31.6% (14,344) of the housing units were built over the same period.

3.2.2.2. Population Characteristics

Household Size

The average number of persons per household in St. Charles County declined from 3.54 in 1970 to 3.07 in 1980 (Table 3-22). This decline is consistent with the nationwide trend toward smaller households as a result of later marriages, smaller families (decreased fertility rate), and increased numbers of one- and two-person households. The City of St. Charles also experienced a decline in average household size from 3.23 in 1970 to 2.69 in 1980 (US Department of Commerce 1982). Similar data for the City of St. Peters are not available.

The average household size in the St. Louis metropolitan area in 1980 was 2.77 (US Department of Commerce 1982). This represents a decline from the 3.16 average household size recorded in 1970 for the region. As these figures indicate, St. Charles County and St. Peters have relatively larger households, as compared to the region, and the City of St. Charles has relatively smaller households. These differences are related to the lower median ages in St. Charles County and St. Peters, as compared to the region, and increased labor force participation rates. Conversely, the City of St. Charles has a somewhat older population, and although its labor force participation rate is less than that of St. Peters or the County, it is greater than the region's labor force participation rate (Table 3-22). These factors influence household characteristics and formation in several ways, but in general, a community characterized by a large proportion of residents in the 26 to 44 age cohorts will have larger households than a community with a greater proportion of residents over 45. These aspects of the population are discussed in more detail in the following sections.

Table 3-22. Selected population characteristics in the planning area in 1970 and 1980 (US Census Bureau 1972 and 1982).

Jurisdiction	Population		Persons per Household		Median Age		Percent Under 18 Years		Percent 65 Years & Over		Labor Force Participation Rates	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
St. Charles County	92,954	144,107	3.54	3.07	24.2	27.6	41.1	33.5	5.8	6.0	63.5	70.9
St. Charles City	31,834	37,379	3.23	2.69	25.9	29.6	36.7	28.0	7.8	9.9	64.0	69.4
St. Peters	486	15,700	--	3.16	--	26.5	--	36.6	--	2.7	--	75.6
St. Louis SMSA	2,410,884	2,356,460	3.15	2.75	28.2	30.6	35.5	28.3	9.8	11.7	--	63.9
Missouri	4,676,501	4,916,686	2.98	2.67	29.4	30.9	33.2	27.7	12.0	13.2	57.2	60.5

Dashes indicate that data are unavailable.

Median Age

Median age is an index of the overall age structure. Between 1970 and 1980, the population of the US aged as a result of the declining fertility rates that have occurred since approximately 1965. The median age in the US in 1970 was 28.1 and in Missouri it was 29.4. According to the 1980 census, the median ages in the US and in Missouri were 30.0 and 30.9, respectively (Table 3-22). The median age in St. Charles County also increased during this decade from 24.2 to 27.6 (Table 3-22). The median ages in St. Peters and the City of St. Charles in 1980 were 26.5 and 29.6, respectively (US Department of Commerce 1982).

The comparatively lower median ages in St. Charles County, and the cities of St. Charles and St. Peters are an indication of the attraction of this area to families in the 25 to 44 age cohorts (the product of the post war "baby boom") with young children. The higher median age in the City of St. Charles, as compared to St. Peters and the County, correlates with the comparatively smaller average household size of that city, as well as the lower percentage of residents under 18 and the higher percentage of residents 65 and over (Table 3-22). Taken together, these factors also correlate indirectly with the comparatively lower growth rate experienced in the City of St. Charles from 1970 to 1980 as a result of lower population increases attributable to natural increase.

Conversely, St. Peter's populace has a lower median age than St. Charles City or County, and, as would be expected, a greater percentage of persons over 18, a lower percentage of persons 65 or over, and a larger average household size. These factors also correlate with the high growth rate experienced in St. Peters from 1970 to 1980.

3.2.2.3. Population Projections

Accuracy in the development of population projections is highly dependent on two factors: the size of the base population, and the time for which the projections are made. The estimation of population generally is less accurate for small populations than for larger populations over long periods of time. This is because attitudinal, technological, or external economic changes can significantly affect small communities, whereas larger communities can better absorb such changes.

The effect of these limitations can be minimized if population projections are based on observations derived from a thorough analysis of historical trends and future expectations. Three observations regarding population trends in the planning area must be considered in forecasting future population levels:

- The population in St. Charles County has increased substantially since 1950. The diffusion of population outward from the central city of older, metropolitan areas - the "suburbanization" of the city - is a well documented trend. The population in many older US cities has been stagnant, or has declined, as a result of increased mobility, increased affluence, and the dispersal of centers of employment throughout metropolitan areas. These factors have led to rapid growth in the "collar" counties that surround the City of St. Louis. Although St. Charles County has "captured" a significant proportion of this growth, the growth rates for the County, including the incorporated and unincorporated portions, were lower in the 1970s than in the 1950s or 1960s. This lessening of the growth rate was particularly apparent in the City of St. Charles where the growth rate from 1970 to 1980 (17.2%) was considerably less than the growth rates experienced during the 1950s and 1960s (48.0% and 50.2%, respectively). This trend is not a factor, though, in St. Peters which has experienced essentially all its development since 1970.

- The relationship between population change in St. Charles County and population change in the City of St. Charles and in the unincorporated portion of the County generally has been stable over the period from 1950 to 1980 (Table 3-23). The ratio of the St. Charles City population to the County population has decreased relatively consistently since 1950, from 48.0 to 25.9%. The ratio of the incorporated portion of St. Charles County to the unincorporated portion has exhibited more variability, but the indications are that the ratio is stabilizing near the 50% level. These factors do not apply to St. Peters because of the extremely high growth that community has experienced since 1970.

- The demand for new housing remains high. The "Golden Triangle," the area bounded by the Norfolk and Western Railroad, Route 40-61, and the Missouri River, exhibits the necessary prerequisites for continued population growth. These include: good intra and inter-regional transportation access, large amounts of vacant buildable land, proximity to employment centers and retail businesses, adequate infrastructure, and City and County pro--growth development policies. The preliminary population projections developed by EWGCC allocate 66.8% (50,400 persons) of the expected growth in the unincorporated County population to the Golden Triangle (both North and South planning areas).

Table 3-23. Percentage of St. Charles City, unincorporated St. Charles County, and incorporated St. Charles County population to the overall County population from 1950 to 1980 (EWGCC 1982).

Jurisdiction	1950	1960	1970	1980
City of St. Charles	48.0	40.0	34.2	25.9
Unincorporated St. Charles County	42.4	45.8	53.4	50.6
Incorporated St. Charles County	57.6	54.2	46.6	49.4

Because the planning area contains three separate sewer service areas, the cities of St. Charles and St. Peters, and the Duckett Creek Sewer District, population projections were developed for each service area.

City of St. Charles

According to the 1980 census, there are approximately 48,118 persons within the City's service area. The City's service area contains two subareas, a Mississippi River subarea and a Missouri River subarea. The Mississippi River subarea has an estimated 1980 population of 32,400 and is served by the St. Charles Mississippi River wastewater treatment plant. The Missouri River subarea has an estimated 1980 population of 15,718 and is served by the Missouri River, St. Charles Trails, and Heatherbrook lagoon wastewater treatment plants. The wastewater treatment alternatives will include wastewater flow projections that differentiate between wastewater flows within the Mississippi and Missouri watersheds. Accordingly, separate population projections were developed for the two subareas.

In order to develop population projections for the service area, a noncomponent projection method was used which assumes that the ratio of the service area population to the County population will remain constant over the planning period. The resulting service area projections were disaggregated between the two subareas by assuming that the subareas' proportion of the overall service area population also will remain constant during the planning period. A noncomponent method was selected because such projection methods do not require explicit assumptions about births, deaths, and net migration. Instead, noncomponent methods only require assumptions about the amount and pace of population change in developing projections of the total population.

In 1980, the population within St. Charles' service area represented 33.4% of the overall County population. Although the percentage of the City's population to the overall county population has decreased since 1950 (Table 3-23), the percentage of the unincorporated County population to the overall County population has increased since 1950 indicating that the County is growing at a relatively greater rate than the City of St. Charles. The City of St. Charles service area includes both the area within the existing city limits as well as unincorporated areas. The amount of vacant buildable residential land within the existing City limits is limited. There are, however, substantial amounts of vacant residential land within the service area, particularly south of I-70. Accordingly, the assumption that the service area will continue to account for 33.4% of the County's population appears to be reasonable given the limited growth potential of the existing City coupled with the high growth potential of the area south of I-70.

This percentage was applied to the St. Charles County population projections prepared by EWGCC. The Draft Unincorporated St. Charles County Land Use Plan (1982) states:

> The St. Charles County projected year 2000 population selected for the preparation of this land use plan comes from a St. Louis region projection made by the East-West Gateway Coordinating Council and adopted by the Council's Board of Directors in 1977. The Gateway projection calculated expected population change for the 8 St. Louis regional counties from 1970 to 2000. The methodology employed age group specific vital rates (cohort survival) procedures, and fertility and migration rate assumptions (component method).

Of the three levels of projections that were produced from this methodology, the "high" level was selected for the preparation of the Unincorporated St. Charles County Land Use Plan. The high level assumes a stable fertility rate (producing a natural increase in population), and a 1980 to 2000 migration rate that is one-quarter of the 1950 to 1970 migration rate. The year 2000 population projection for St. Charles County that was derived from these assumptions is 244,000 (EWGGC 1982).

Based on the assumptions cited, the City of St. Charles' service area would have 1990 and year 2000 populations of 63,600 and 81,500, respectively (Table 3-24).

Table 3-24. Population projections for the City of St. Charles service area and Mississippi and Missouri River subareas.

Area	1980	1985	1990	1995	2000	2005[b]
St. Charles service area	48,100	55,000	63,600	72,400	81,500	89,800
Mississippi River subarea	32,400	37,100	42,900	48,800	54,900	60,500
Missouri River subarea	15,700	17,900	20,700	23,600	26,600	29,300
St. Charles County[a]	144,107	164,800	190,300	216,800	244,000	269,000

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[a] EWGCC projections

[b] Straight line projection based on 1980 to 2000 growth rates.

The 1980 population of the Missouri River subarea (15,700) represents 32.6% of the 1980 population of the St. Charles service area. The Mississippi River subarea's 1980 population (32,400) represents 67.4% of the service area's 1980 population. Assuming that these percentages also will remain constant, the Missouri River subarea would have 1990 and year 2000 populations of 20,700 and 26,600, respectively, and the Mississippi River subarea would have 1990 and year 2000 populations of 42,900 and 54,900, respectively. These projections indicate that the Missouri River subarea will increase by 10,900 from 1980 to 2000 and the Mississippi River subarea will increase by 22,500 during the same period.

The validity of the assumptions that were used to develop the projections is borne out by an analysis of vacant residential land in the service area. The Mississippi River subarea contains approximately 3,400 acres of vacant land and the Missouri River subarea contains approximately 1,570 acres of vacant land. Assuming a composite residential density of 9 persons per acre (3 units per acre and 3 person per household), the Mississippi River subarea requires an additional 2,500 acres of vacant residential land to accommodate the projected population and the Missouri River subarea requires 1,211 acres. The population projections for the service area and the two subareas are summarized in Table 3-24.

City of St. Peters

The City of St. Peters recently adopted a Comprehensive Plan which establishes a general guide for the future growth of the City. The Plan was prepared in 1982 and contains population projections for the City to the year 2000.

According to the Plan:

> The population projections for St. Peters were based on estimates derived from the City's past and future development plan, taking into consideration the following: 1.) current water customer projections; 2.) existing and residential in-fill; 3.) building data; and 4.) annexation policies.

The population projections were developed for the City's planning area which encompasses an area generally bounded by the Norfolk and Western Railroad on the north, the City of St. Charles on the east, Route 94 on the south, and St. Peters-Howell Road/Dardenne Creek/Belleau Road on the west. The planning area includes a portion of the Duckett Creek Sewer District's sewer service area as well as a portion of the City of St. Charles sewer service area. In addition, a portion of St. Peters' sewer service area is not included in the City's planning area.

The portion of the City's planning area that is within Duckett Creek's service area includes the Park Charles subdivision as well as the subdivisions between Park Charles and Route 94. The portion that is within St. Peter's sewer service area but outside the planning area is bounded by Dardenne Creek, St. Peters-Cottleville Road, Knaust Road, and Mexico Road. Although this area (hereinafter referred to as the "Knaust Road area") contains approximately 2,600 acres to the approximately 1,600 acres in the Park Charles area, the two areas are assumed to have approximately the same development potential because the floodplain adjacent to Dardenne Creek and the large agricultural holdings in the Knaust Road area limit the development potential of this area to some degree.

The Park Charles area is accounted for in the St. Peters population projection because it is within the planning area, but the Knaust Road area is not included in the projection. The Knaust Road area must be accounted for in developing service area population projection for St. Peters, though. The Park Charles area must be excluded from the St. Peters service area projection and included in the population projection for the Duckett Creek Sewer District's service area. However, because the two areas have essentially the same development potential, St. Peters' planning area projection does not have to be modified to compensate for the geographic differences between the City's sewer service area and planning area.

The portion of the City's planning area that is within the City of St. Charles' service area is bounded by Muegge Road on the east, Hackman Road on the south, and the present St. Peters city limits on the west and north. This area can accommodate approximately 2,500 residents and is assumed to be accounted for in the population projections for the City of St. Charles (Mississippi River subarea). Accordingly, St. Peters population projection must be reduced by 2,500 to compensate for this overlap.

The population projections for St. Peters contain two growth scenarios - a moderate growth scenario and a fast growth scenario. Under the moderate growth scenario, in which future growth rates are assumed to moderate, the City projects 1990 and year 2000 populations of 27,000 and 37,000, respectively. Under the fast growth scenario, in which current growth rates are assumed to continue, the 1990 and year 2000 projections are 32,000 and 42,000, respectively. For the purposes of developing wastewater treatment alternatives, projections between these two figures, i.e., 30,000 and 40,000 are assumed to be reasonable. After substracting the 2,500 residents included in this projection that are within the City of St. Charles service area, the estimated year 2000 population within the St. Peters service area is 37,500. Assuming a continuation of the growth rate reflected in this projection to the year 2005, the resulting population projection for St. Peters for the planning period is 43,000.

Duckett Creek Sewer District

Since 1977 when the Duckett Creek Sewer District was formed, the number of connections to the system has increased from 3,667 on 1 January 1978, to 6,806 on 1 January 1983 (Personal communication, Mr. Dick Schall, Duckett Creek Sewer District, to WAPORA, Inc., 5 January 1983). Over this 5-year period, the District has added an average of 629 connections per year. In addition, during the past few years the District has maintained an inventory of 3,000 to 3,400 planned housing units in developments with vacant improved lots or in subdivisions that have received preliminary approval. These planned housing units typically become connected to the District's system within 3 years. Thus, it appears that the current high development rate within the District will continue for at least the next few years.

Based on the number of connections to the system, the District was serving a population of 16,122 in 1980. This is based on a total of 5,207 connections in 1980, minus 169 commercial or institutional connections, times a persons per unit factor of 3.2 (Personal communication, Mr. Dick Schall, Duckett Creek Sewer District, to WAPORA, Inc., 5 January 1983). It is not possible, though, to estimate the actual 1980 population within the Sewer District's service area. A substantial number of housing units within the Sewer District's service area are not connected to the District's wastewater collection system and rely on onsite systems (e.g., septic tanks) for wastewater treatment. Sverdrup & Parcel and Associates, Inc. (1982b) has estimated that there are approximately 11,000 residences using onsite systems within the facilities planning area. A large proportion of these are within the Sewer District's service area.

According to EWGCC, the unincorporated portions of the Golden Triangle North and South planning areas had a 1980 population of 50,287. As discussed previously, some of this population is within the service areas of St. Peters and the City of St. Charles, but because these residents are in unincorporated areas, they are not accounted for in the Cities' 1980 census populations. The area within the Golden Triangle planning areas and the two cities, essentially encompasses the area represented by the sewer service areas of the three entities. Thus, by adding the 1980 populations of the cities of St. Charles and

St. Peters (37,379 and 15,700, respectively) to the population within the unincorporated portions of the Golden Triangle (50,287), a 1980 population estimate of 103,366 can be derived for the three sewer service areas. This population represents 72% of the total population within St. Charles County.

Because of the difficulties in estimating the 1980 population within the Sewer District's service area and the limited data that are available on historic population growth within this area, it is also difficult to develop a population projection for the Duckett Creek Sewer District. Given these difficulties, it was determined that an indirect ratio-trend method would be most appropriate for estimating the future population of the Duckett Creek Sewer District. Because a year 2000 projection has been developed for the entire County, by making assumptions about the ratio between the total population within the three services areas and the County population, the year 2000 population within the Duckett Creek Sewer District can be derived.

The 1980 ratio of the three service area's population to the County population (72%) reflects the rapid growth that has occurred in the Golden Triangle since 1970. In addition, the EWGCC estimates that this area will account for a substantial proportion of the County's future growth. Accordingly it was assumed that the ratio of the overall service area population to the County population would remain constant over the planning period. By applying this ratio to the year 2000 projection for St. Charles County (244,000), a year 2000 population projection for the three service areas of 175,700 is derived. The previously discussed year 2000 projections for the St. Peters and City of St. Charles service areas, 37,500 and 81,500, respectively, account for 119,000 persons. After subtracting the 119,000 persons accounted for in these projections, a year 2000 projection for the Duckett Creek Sewer District service area of 56,700 is obtained.

Implicit in this projection is the assumption that 72.3% of the growth projected for St. Charles County between 1980 and 2000 will occur in the area represented by the service areas of the Duckett Creek Sewer District, St. Peters and the City of St. Charles. Given historic growth trends within this area, this assumption appears to be reasonable. In addition, the combined year 2000 population projections for the three service areas represent an annual average growth rate of 2.7%. This corresponds to the 2.6% average annual growth rate reflected in the overall St. Charles County projection.

Duckett Creek Watershed

The population projection for the Duckett Creek Sewer District must be disaggregated to identify the portion of the service area population residing within the Duckett Creek watershed. Because Duckett Creek flows into the Missouri River, and the rest of the Sewer District's service area drains into the Mississippi River, separate wastewater flow projectons must be developed for the Duckett Creek watershed. As of 1 January 1983, there were 2,132 connections in the Duckett Creek watershed to the District's system (Personal communication, Mr. Dick Schall, Duckett Creek Sewer District, to WAPORA, Inc., 5 January 1983). This represents a population of 6,882 at 3.2 persons per household.

The Duckett Creek watershed contains approximately 2,447 acres. Assuming an average of 2.29 units per acre (EWGCC 1982), residential land use within the watershed accounts for approximately 931 acres. After subtracting steep slope areas, and land needed for roads, parks, schools and other non-residential uses, the ultimate residential development potential of the watershed is estimated to be approximately 1,600 acres. Thus, at 6.98 persons per acre - the average residential density for the Golden Triangle South planning area (EWGCC 1982) - the Duckett Creek watershed at "buildout" will have a population of approximately 11,200. It is also assumed that this population level will be achieved during the planning period. Accordingly, separate year 2000 and 2005 projections for the Duckett Creek watershed have not been developed. This projection represents an increase of 64.2% over the 1983 population of the watershed. After subtracting the estimated year 2005 population in the Duckett Creek watershed from the overall population projection for the Sewer District's service area, the remainder of the service area is estimated to have a year 2005 population of 49,650.

The population projections for the separate service areas and subareas are summarized in Table 3-25.

Table 3-25. Population projections for the City of St. Charles, St. Peters, and Duckett Creek Sewer District.

Area	1980	1985	1990	1995	2000	2005 [d]
City of St. Charles Service Area	48,100	55,000	63,600	72,400	81,500	89,800
Mississippi River Subarea	32,400	37,100	42,900	48,800	54,900	60,500
Missouri River Subarea	15,700	17,900	20,700	23,600	26,600	29,300
St. Peters	15,700	21,200	27,500	32,300	37,500	43,000
Duckett Creek Sewer District	16,122[a]	42,500[b]	45,900[b]	51,400[b]	56,700[b]	60,850[b]
Duckett Creek Watershed	6,822	8,300	9,300	10,400	11,200	11,200
Remainder of Service Area	9,300[a]	34,200[b]	36,600[b]	41,000[b]	45,500[b]	49,650[b]
Combined Service Area	103,366	118,700	137,000	156,100	175,700	193,700
St. Charles County[c]	144,107	164,800	190,300	216,800	244,000	269,000

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[a] Actual population served; does not include residences within the service area served by onsite systems.

[b] Estimated population within service area; includes some residences served by onsite systems.

[c] EWGCC projections.

[d] Straight line projections based on 1980 to 2000 growth rates.

3.2.3. Local Economic Characteristics

The economy of a given area can be characterized by describing the economic output or activity in terms of basic production and non-basic, or service production. The basic sector of the economy produces goods or services exported to other areas while the non-basic sector produces goods and services for local consumption. The most commonly utilized criterion to guage economic output or activity is employment by industry category.

Basic Sector

The specific components of the basic sector may vary with locale, but generally include the agriculture, mining, and manufacturing industry categories. In the St. Louis SMSA, the number of basic sector workers decreased by 42.7% between 1970 and 1980, while in St. Charles County, basic employment increased by almost 17% during the same period (US Department of Commerce [USDOC] 1970, 1980; Table 2-6). The increase in basic employment in St. Charles County is attributed primarily to the moderate increase in the manufacturing category. Likewise, the substantial decrease in the St. Louis SMSA basic employment resulted from a significant decrease in manufacturing employment.

In both the SMSA and St. Charles County, agricultural employment increased and mining employment decreased during the 1970s (USDOC 1970, 1980). The agricultural and mining categories, however, are not significant when compared to the manufacturing employment category and, therefore, have little effect on total basic sector employment.

Non-Basic Sector

The non-basic sector of the economy includes the contract construction; transportation/public utilities; wholesale and retail trade; finance, insurance, and real estate (FIRE); and services employment categories. During the 1970s, non-basic employment declined slightly (8.6%) in the St. Louis SMSA, but more than doubled (122.9%) in St. Charles County (USDOC 1970, 1980; Table 3-26). Non-basic employment in St. Charles County increased for each employment category, ranging from a 79.4% increase for the FIRE category to 210%

Table 3-26. St. Charles County and St. Louis SMSA employment trends by sector, 1970 and 1980

Category	St. Charles County			St. Louis SMSA[1]		
	1970	1980	Percent Change 1970-1980	1970	1980	Percent Change 1970-1980
Total employment	15,891	29,215	83.8	770,426	607,916	-21.1
Basic						
Agriculture	20	100	400.0	1,240	2,233	80.1
Mining	122	44	63.9	2,942	2,620	-10.9
Manufacturing	5,630	6,597	17.2	285,486	161,119	-43.6
Total Basic	5,772	6,741	16.8	289,668	165,972	-42.7
Non-Basic (service)						
Contract Construction	1,248	2,324	86.2	37,999	38,101	0.3
Transportation/Public Utilities	956	2,017	111.0	52,363	37,923	-27.6
Wholesale Trade	341	1,057	210.0	57,761	41,609	-28.0
Retail Trade	3,770	7,720	104.8	136,954	136,189	-0.6
F.I.R.E	733	1,315	79.4	49,007	36,656	-25.2
Services	3,017	7,640	153.2	145,092	145,190	0.1
Other	18	401	2,128.0	1,582	3,851	143.4
Total Non-Basic	10,083	22,474	122.9	480,758	439.519	-8.6
Basic: Non-Basic Multiplier	1.75	3.33	—	1.66	2.65	—

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[1] St. Louis SMSA in 1980 includes two Illinois counties that were not part of the SMSA in 1970.

SOURCE: USDOC 1970, 1980

for the wholesale trade category. Non-basic employment categories in the St. Louis SMSA generally held steady or declined, with transportation/public utilities, wholesale trade, and FIRE declining by more than 25% between 1970 and 1980.

Basic/Nonbasic Employment Ratio

The basic/nonbasic ratio is an indicator of the overall structure of an urban economy. In the St. Louis SMSA as a whole, the employment ratio or multiplier was 1.66 (USDOC 1970). By 1980, this ratio had risen to 2.65, indicating an increase in nonbasic employment and a corresponding decrease in basic employment opportunities in the SMSA (USDOC 1980). The St. Charles County employment ratio also increased significantly between 1970 and 1980. In 1970, there was 1.75 nonbasic jobs for each basic job, but by 1980 the ratio increased to 3.33 jobs in the non-basic sector for each basic sector job. Unlike the St. Louis SMSA, the increase in the ratio of nonbasic jobs in St. Charles County is due to the substantial increase in the nonbasic sector instead of decrease in the basic sector. The opening of an automobile manufacturing facility in St. Charles County in 1983 enhanced the employment multiplier by adding several thousand basic employment positions in the County.

Labor Force

The total employment in St. Charles County increased at a higher rate than the County's population between 1970 and 1980. Total employment increased by 83.8% during the 1970s while the population increased by 55% during the same period. In the St. Louis SMSA, employment levels decreased by 21% during the 1970s while population levels decreased by only 2.3%.

The average annual unemployment rate in St. Charles County has ranged from 4.7% in 1978 and 1979 to 8.4% in 1982. Annual unemployment rates in the St. Louis SMSA have been consistently higher than in St. Charles County, ranging from 5.4% in 1979 to 9.0% in 1982 (Table 3-27). In recent years, layoffs in the auto industry and other large manufacturers have contributed significantly to the number of unemployed in the St. Louis area.

Table 3-27. St. Charles County and St. Louis SMSA average annual unemployment rate trends, 1977-1982 (By phone, Mr. Russ Signorino, MO Division of Employment Security, to WAPORA, Inc., 19 January 1983).

Year	St. Charles County	S. Louis SMSA
1977	6.1	6.6
1978	4.7	5.6
1979	4.7	5.4
1980	7.8	8.1
1981	7.0	8.5
1982	8.4	9.7

3.2.4. Local Financial Status

3.2.4.1. Income Levels

The 1979 per capita and median household income levels of residents of St. Peters, the City of St. Charles, St. Charles County, and the St. Louis SMSA are higher than residents of the State as a whole. The income of residents of St. Peters is significantly higher than the residents of Missouri in terms of per capita and median household incomes (Table 3-28).

Between 1969 and 1979, per capita income increased in St. Charles County and the City of St. Charles at a greater rate than the State. The per capita income of the County's residents increased from $2,965 in 1969 to $7,679 in 1979, a 158.9% increase. Per capita income in the City of St. Charles increased by 145.3% from $3,215 in 1969 to $7,888 in 1979. St. Peters' residents had the highest per capita income in 1979 at $8,030.

Median household income levels in the planning area ranged from $19,667 in St. Charles to $25,037 in St. Peters in 1979 (Table 3-28). Median household income in Missouri was only $15,581 in 1979. Overall, it may be stated that the households in the planning area are signficantly more affluent than in the remainder of the State or the St. Louis SMSA.

Table 3-28. Per capita and median household income characteristics, 1969 and 1979 (USDOC 1978, 1982).

	Per Capita Income			Median Household Income		
	1969	1979	Percent Increase	1969	1979	Percent Increase
Missouri	2,983	6,919	131.9	7,672	15,581	103.1
St. Louis SMSA[1]	3,331	7,667	130.2	9,362	18,628	98.9
St. Charles Co.	2,965	7,679	158.9	N.R.	22,408	--
City of St. Charles	3,215	7,888	145.3	N.R.	19,667	--
St. Peters	N.R.	8,030	--	N.R.	25,037	--

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[1] St. Louis SMSA in 1979 includes two Illinois counties that were not part of the SMSA in 1970.

N.R. - Not reported in 1970 Census.

3.2.4.2. Local Government and Special District Finances

This section describes the general financial conditions of the three government bodies and one special district in the planning area. The information is based upon the most recent annual financial status reports published by St. Charles County, the City of St. Charles, St. Peters, and the Duckett Creek Sewer District.

Local Government Finances

Selected financial characteristics of St. Charles County, the City of St. Charles and St. Peter are indicated in Table 3-29. Each government operates with a different fiscal year as indicated in the Table. Bonded indebtedness ranges from approximately $6.5 million for the City of St. Charles to over $12 million for St. Peters. Correspondingly, St. Peters has a substantially higher debt per capita, $766 versus $52 and $31 for the County and St. Charles, respectively. The residents of St. Peters also pay more property taxes per capita ($59) than the County ($27) and St. Charles ($43).

Criteria for prudent fiscal management have been developed by several authors. An adaptation of these criteria is presented in Table 3-30. These recommended standards can be compared with relationships developed from the previously discussed data (Table 3-29) to assess local financial conditions. As would be expected in a rapidly growing and economically sound area, all of the jurisdictional values fall below the limits presented in Table 3-30.

Duckett Creek Sewer District Finances

The Duckett Creek Sewer District is a quasi-governmental agency that is responsible for its own financial accounting. During 1981, the District received revenues of $772,820 composed largely of sewer service charges ($567,7430) and connection fees ($111,718). After budgeted transfers of some of the revenues to other funds, the total revenues received by the District in 1981 was $511,937. Expenditures during 1981 totalled $455,864 of which $315,894 was spent for operation, $88,561 for administration, $43,114 for general expenditures, and $8,295 for emergency expenditures.

Table 3-29. Selected financial characteristics for planning area governments.

	St. Charles County	City of St. Charles	City of St. Peters
Fiscal Year Ending	12/31/81	06/30/82	10/30/82
Assessed Valuation	609,617,010	127,379,123	92,414,022
Full Valuation	NA	382,137,369	420,060,000
Statutory Debt Limit[1]	NA	12,737,912	9,241,402
Debt	7,500,000	6,505,500	12,019,000
Debt Payment	0	568,110	335,170
Prop. Tax Revenues	3,892,977	1,611,925	926,788
Other Revenues	1,639,071	8,932,625	4,017,289
Adj. Gross Income	1,106,600,000	294,850,000	126,860,000
Population	144,107	37,379	15,700
Debt Per Capita ($)	52	131	766
Debt to Full Value (%)	NA	1.7	2.9
Debt Service to Revenue (%)	NA	5.4	7.2
Debt to Income (%)	0.7	2.2	9.4
Tax Per Capita ($)	27	43	59

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[1] Statutory debt limit applies only to general obligation bond debt.

NA - Not Available.

Table 3-30. Criteria for local government full-faith and credit debt analysis (Adapted from Moak and Hillhouse 1975, and Aronson and Schwartz 1975).

Debt Ratio	Standard Upper Limit for Debt
Debt per Capita	
Low Income	$ 500
Middle Income	1,000
High Income	5,000
Debt to Market Value of Property	10% of current market value
Debt Service to Revenue (or Budget)	25% of the local government's total budget
Debt to Personal Income	7%[1]

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[1] Not an upper limit, but the national average in 1970.

As of 31 December 1981, the Sewer District had outstanding bonded indebtedness of $3,350,00 which consisted of four issued series of revenue bonds. These bond issues are:

- Revenue Bonds - Series A: serial bonds dated 1 December 1977 bearing interest at 8% per annum payable semiannually. Bonds are in $5,000 denominations and are due beginning on 1 December 1988 to 1 December 2007. Total issue is $550,000.
- Revenue Bonds - Series B: Junior Lien of Series A bondholders dated 31 December 1977 bearing interest at 8% per annum. Bonds are in $5,000 denominations and are due beginning 1 December 1988 to 1 December 2007. Total issue is $1,300, 000.
- Revenue Bonds - Series C: serial bonds dated 1 June 1980 bearing interest variably from 10 to 8.5% per annum and are payable semiannually. Bonds are in $5,000 denominations and are due beginning 1 December 1984 through 1999. Total issue in $400,000.
- Revenue Bonds - Series D: serial bonds dated 1 April 1981 bearing interest variably from 8.75 to 10.50% per annum payable on 1 December and 1 June in each year. Bonds are in $5,000 denominations due from 1 December 1986 through 2001. Total issue in $1,100,000.

3.2.5. Infrastructure

3.2.5.1. Wastewater Treatment

Four public sewer agencies provide wastewater collection and treatment services to more than half of the planning area. These agencies include the Duckett Creek Sewer District which operates four wastewater treatment plants, the City of St. Charles which operates four treatment plants, the City of St. Peters which operates one treatment facility, and the City of Portage Des Sioux which operates a community septic tank facility. In addition to these publicly operated treatment facilities, there are six other privately owned domestic wastewater treatment facilities and six privately owned industrial wastewater treatment facilities in the planning area. The majority of the densely populated portions of the planning area are served by one of the centralized systems described above. The small isolated communities and rural areas in the planning area continue to rely on individual onsite systems for their wastewater treatment needs.

3.2.5.2. Solid Waste Disposal

The approximately 154 tons of residential solid waste and the approximately 51 tons of commercial refuse generated daily in St. Charles County are disposed of in one of five landfills located outside of the county. Approximately 95% of the solid waste is landfilled in two disposal facilities located in St. Louis County: West Lake Landfill and Fred Weber Landfill Inc. The remaining solid waste generated in St. Charles County is hauled to three smaller landfill operations: J. Z. Disposal Inc. in Warren County, Trucker Landfill, and Franklin County Sanitary Landfill - both in Franklin County (St. Charles County Planning Department [SCCPD] 1981).

Capacity studies of the two major landfills serving St. Charles County's disposal needs have been prepared by the Missouri Department of Natural Resources. These projections were prepared in 1980 and indicate that the West Lake Landfill should achieve its design capacity in 1983 while the Fred Weber Landfill, Inc. should remain active until 1988. The closing of other disposal facilities in the St. Louis SMSA could significantly affect these projections. The St. Charles County Planning Department has identified four general areas in the County as possible future locations for landfills pending detailed engineering studies (SCCPD 1981):

- The general area of State Highway W, north of I-70.
- The general area east of State Highway T between State Highway N and State Highway D.
- The general area along State Highway N between US Highway 40-61 and State Highway Z.
- The general area along State Highway D, east of State Highway DD.

Collection and transportation of residential and commercial solid waste in St. Charles County is performed by approximately 23 independent refuse haulers regulated and licensed by the St. Charles County Health Department under the County's Solid Waste Management Plan. Fifteen of these haulers are primarily residential refuse carriers and the remaining eight service commercial waste generators.

3.2.5.3. Health Care

The residents of the planning area and St. Charles County in general are provided an adequate level of health care service. Over 130 medical doctors provide medical services to the public through private clinics or the two major health care centers in the planning area. Although there are a number of small hospitals in St. Charles County, the two major health care facilities located in the planning area are the St. Peters Community Hospital in St. Peters and the St. Joseph Health Center in St. Charles. Both facilities provide emergency medical care and are served by the St. Charles County Ambulance District. Residents of the planning area can also receive health care services from a variety of facilities in the St. Louis area.

3.2.5.4. Law Enforcement

Within the planning area, three law enforcement agencies have the responsibility for providing protection of local citizens (Table 3-31). The St. Charles County Sheriff's Department, headquartered in the City of St. Charles, is responsible for all areas of the County. The Sheriff's Department employs a total of 88 persons: 39 road offices; 6 detectives; 4 identification specialists; and 39 jailers, bailiffs, warrant servers and administrative personnel (Heusler 1983). The City of St. Charles' Police Department has a force of

70 officers with a reserve force of 15, and a support staff of 25 persons. The remaining law enforcement agency in the planning area, the City of St. Peters Police Department, has 30 officers, 15 reserve officers, and a support staff of 8.

Crime statistics for St. Charles County indicate a significant increase between 1970 and 1981 for seven crime reporting categories (murder, assult, rape, robbery, burglary, theft, and motor vehicle theft). During this period, reports of criminal acts increased by an average of 26% per year. However, between 1981 and 1982 these criminal occurrences increased by only 4% (Heusler 1983).

Table 3-31. Inventory of law enforcement services in the planning area.

Law Enforcement Agency	Full-Time Officers	Reserve Officers	Support Staff	Ratio Officers/ 1000 Population
St. Charles County Sheriff	49	-	39	.7
City of St. Charles Police Department	70	15	25	1.8
City of St. Peters Police Department	30	15	8	1.9

3.2.5.5. Fire Protection

Fire protection services in the planning area are provided by three departments with full time staffing and by three volunteer departments (Table 3-32). The largest fire protection organization is the City of St. Charles Fire Department which has a full-time staff of 61 distributed between five stations. With five pumper trucks, two aerial opperative trucks, and three special duty trucks, this fire department has an insurance rating of 5.

The St. Peters Fire Protection District (F.P.D.) has a full-time staff of 9 firefighters with a volunteer force of 45, and the District has two stations. The area served by this organization currently has an insurance rating of 6. Five pumpers, one tanker, and one special duty truck are maintained by the St. Peters F.P.D.

Table 3-32. Inventory of planning area fire protection services (Litteken 1983).

District/Department	Personnel		No. Stations	Equipment				Insurance Rating
	Paid	Vol.		Pumpers	Tankers	Aerial	Special Duty	
St. Peters Fire Protection District	9	45	2	5	1	-	1	6
City of St. Charles Fire Department	61	-	5	5	-	2	3	5
St. Charles Fire Protection District	-	66	4	5	1	1	2	6
Portage Des Sioux Volunteer Fire Dept.	-	25	1	1	1	-	1	8
Orchard Farms Volunteer Fire Department	-	27	1	2	-	-	2	9
Cottleville Fire Department	2	45	2	4	-	-	2	6

The Cottleville Fire Department maintains a full-time staff of two firefighters and has a volunteer force of 45. This department has two fire stations and has a insurance rating of 6 with four pumper tanks and two special duty vehicles.

The three volunteer departments, St. Charles Fire Protection District, Portage Des Sioux Volunteer Fire Department, and Orchard Farms Volunteer Fire Department, have a total of 118 volunteers and primarily serve the more rural areas of the planning area.

In addition to the fire protection services described above, mutual aid agreements commit the equipment and personnel of seven additional fire departments within the county. In the case of a major fire or other disaster, the combined efforts of these fire departments can be utilized to protect public safety and health.

3.2.5.6. Public Education

Public education is provided to residents of the planning area through four school districts. The Francis Howell School District serves the southern third of the planning area including the Cottleville and Harvester areas as well as a large portion of the St. Charles County. The Ft. Zumwalt School District serves St. Peters and areas west and north of St. Peters within the planning area. The St. Charles School District serves the City of St. Charles and the Orchard Farm School District serves the floodplain areas in the northern portion of the planning area including Kampville, South Shore, Orchard Farm, and Portage Des Sioux.

The St. Charles School District has more physical facilities than the other districts (Table 3-33). It had a total 1982 enrollment of approximately 6,195 students in its 7 elementary, 2 junior high, and 2 senior high schools. The St. Charles District also maintains a vocational education facility for eleventh and twelfth grade students.

The Francis Howell School District, with most of its schools located in the rapidly growing portion of the planning area, had the highest enrollment figures in 1982, with approximately 8,830 students. Within the planning area, this district has five elementary schools and three junior high schools. A senior high school is located just outside the planning area and serves the entire school district.

Table 3-33. Planning area school enrollment and estimated capacities.

School District	School	Grades	Enrollment	Est. Capacity
Francis Howell	Castlo E.S.	K-6	489	485
	Central E.S.	K-6	1,108	1,280
	Fairmount E.S.	K-6	1,746	1,650
	Weldon Spring E.S.[1]	K-6	165	175
	Becky-Davis E.S.	K-6	1,087	1,280
	Hollenbeck J.H.S.	7-9	1,058	1,075
	Henderson J.H.S.	6-7	329	640
	Barnwell J.H.S.	7-9	992	1,075
	Francis Howell H.S.[1]	10-12	1,858	2,000
Ft. Zumwalt	St. Peters E.S.	1-3	670	600
	Lewis & Clark E.S.	4-6	518	600
Orchard Farms	Orchard Farm E.S.	K-5	613	700
	Orchard Farm M.S.	6-8	298	600
	Orchard Farm H.S.	9-12	419	600
	Kampville E.S.	1-3	60	90
St. Charles	Benton E.S.	K-5	219	420
	Klackhurst E.S.	K-5	370	525
	Coverdell E.S.	K-5	425	756
	Harris E.S.	K-5	441	750
	Lincoln E.S.	K-5	231	288
	Monroe E.S.	K-5	426	700
	Null E.S.	K-5	320	500
	Hardin J.H.S.	6-8	798	1,000
	Jefferson J.H.S.	6-8	765	736
	E. St. Charles H.S.	9-12	1,053	1,662
	W. St. Charles H.S.	9-12	1,147	1,500
	Lewis & Clark Voc. S.	11-12	NA	NA

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[1] Not located within planning area.

The Ft. Zumwalt School District operates two elementary schools within the planning area, both in St. Peters. Approximately 1,200 students were enrolled in these two schools during the 1982 school year. Junior and senior high schools are located just outside the planning area in O'Fallon.

Four elementary, one junior high, and one senior high school are operated by the Orchard Farms School District within the planning area. In 1982, the schools had a combined enrollment of approximately 1,400 pupils.

In general, the schools serving the planning area are not overcrowded at this time. Although a few individual schools have a current enrollment higher than estimated capacity, the overall capacity of the respective school districts is adequate to accommodate existing enrollment. With the rapid population growth occurring in St. Charles County, additional educational facilities will be required in the short-term future regardless of present capacity.

3.2.6 Transportation

The planning area is served by a variety of transportation facilities including highways, rail, air, and water transportation modes. The availability of transportation has been and will continue to be an important factor in the development of the planning area.

3.2.6.1 Highways

The systems of surface roadways in the planning area and St. Charles County in general has played an important role in the urbanization of the area. The highway systems is composed of Interstate and other Federal highways,. state highways, county highways, as well as the local road network. I-70 roughly bisects the County as it extends between St. Louis on the east to Kansas City/Independence on the west. The increased accessibility provided by I-70 has resulted in accelerated urban development in the eastern portion of the County in recent years. Within the planning area, I-70 has five access points, two at St. Charles, two at St. Peters, and one at Muegge Road.

Another Federal highway within the planning area is US 40-61. This four lane highway forms a portion of the southwestern boundary of the planning area and extends northward to Hannibal and beyond.

State highways and the network of county highways complete the roadway system in the planning area. State Highway 94 winds through the planning area extending from the southwest through St. Charles and the northwestern portion of the planning area. The Missouri Highway and Transportation Department also is studying plans for locations for Route 115 (including a Missouri River Bridge) from Route 94 to I-270. The proposed route would begin in St. Charles

County immediately west of Route 94 between the Norfolk and Western Railroad and Route B, then extends eastwardly across the Missouri River and end at I-270 between the Norfolk and Western Railroad and Route 67 (Lindbergh Boulevard). Alternates also being evaluated in the vicinity of the Old St. Charles Missouri River bridge on Route 115. Plans for this road location should be followed closely to determine what effect, if any, it might have on sizing the Boshertown pump station and force main.

3.2.6.2 Rail

Three railroad lines serve or cross the planning area. The Missouri-Kansas-Texas Railroad parallels the Missouri River and forms the southeastern boundary of the planning area. The Norfolk and Western Railroad generally parallels the route of I-70 through the planning area and provides freight services to St. Charles and St. Peters. The Burlington Northern Railroad transects the broad floodplain area in the northern portion of the planning area. Passenger rail service is not available in the planning area.

3.2.6.3 Air

Three airports provide air transportation services to residents of the planning area. Commercial passenger and freight services are available at the Lambert St. Louis International Airport which is located on I-70 within 20 minutes travel time of most parts of the planning area. The St. Charles County Airport is the only public airport within the planning area and has four paved runways with approximately 100 planes based there. A small private airport, St. Charles Airport, is located within the planning area and has three runways with approximately 75 private planes (Office of County Grant Coordinator [OCGC] 1977). Overall, the residents of the planning area have easy access to both private and commercial air transportation services.

3.2.6.4 Water

Although the planning area is bordered by two major navigable waterways, the Missouri and Mississippi rivers, waterborne commerce initiating within the project area is negligible (OCGC 1977). The nearest port facility to the planning area is the Port of St. Louis in the City of St. Louis.

3.2.7 Energy

The principal sources of energy utilized in the planning area are electricity, natural gas, and fuel oil. These forms of energy are imported into the area because of the lack of coal, oil, or natural gas resources within St. Charles County. Supplies of these energy sources are presently adequate to serve the area.

3.2.7.1. Electricity

Electrical power is supplied to St. Charles County and the planning area by the Union Electric Company and the Missouri Edison Company, both of which are regulated by the Missouri Public Service Commission. In unincorporated areas and incorporated areas of less than 1,500 population, the Cuivre River Electric Cooperative, Inc. provides electric power.

The Union Electric Company's service area encompasses the eastern portion of the county including the cities of St. Charles, Portage Des Sioux, and West Alton. Union Electric's closest generating plant is the Sioux Plant, rated at 950,000 kw, located near Portage Des Sioux. The total capacity of Union Electric's generating network throughout the State is approximately 7 million KW (OCGC 1977).

The Missouri Edison Company serves the western portion of St. Charles County. It is a subsidiary of Union Electric Company and obtains all of its electrical power from Union Electric.

Rural areas in the western portion of the planning area are also served by the Cuivre River Electric Cooperative, Inc. which obtains its power from Associated Electric, a state-wide power cooperative. Electric service can no longer be extended by the Cuivre River Electric Cooperative into incorporated areas with a population of over 1,500.

3.2.7.2 Natural Gas

Natural gas is provided to the cities of St. Charles and St. Peters and the Harvester area by the St. Charles Gas Company, a subsidiary of Laclede Gas Company of St. Louis (OCGG 1977). Areas not serviced by the St. Charles Gas Company system use bottled gas supplied by various local companies.

3.2.7.3 Fuel Oil

Many older homes and buildings rely on fuel oil for heating. This source of energy is available from over 10 distributers in the planning area.

3.2.8 Cultural Resources

3.2.8.1 Laws and Regulations

Cultural resource investigations are required by law when a project involves Federal financing, assistance, or licensing. The requirements are specified in the following Federal regulations and procedures:

- National Historic Preservation Act of 1966 (PL 89-665) (16 U.S.C. 470 et seq.).
- National Environmental Policy Act of 1969 (PL 91-190) (42 U.S.C. 4321 et seq.).
- Executive Order 11593 (Protection and Enhancement of Cultural Environments).
- Archaeological and Historic Preservation Act of 1974 (PL 93-291) (16 U.S.C. 469 et seq.).
- 36 CFR 800 -- Protection of Historic and Cultural Properties.
- 36 CFR 60.6 -- National Register Criteria.
- National Historic Preservation Act Amendment of 1980 (PL 96-515) (16 U.S.C. note 470).

These regulations and procedures stipulate that USEPA, as the Federal permitting agency, has the responsibility to ensure that all properties that could be affected directly or indirectly by any part of the proposed project are identified, evaluated, and either protected or mitigated. Compliance with these regulations and procedures requires a detailed inventory and assessment of the cultural resource that will be affected by the proposed project. The resources must be evaluated to determine their eligibility to the National Register of Historic Places. Existing resources are identified and inventoried through comprehensive surveys. The significance of a site and the potential loss that it represents is evaluated through testing programs subsequent to the survey. If a site is deemed significant and eligible for nomination to the National Register, that site must be mitigated prior to being impacted by the project.

The regulations and procedures require consultation and coordination with the State Historic Preservation Officer (SHPO) during all phases of a cultural resource investigation. Final determination of the significance and eligibility of a site for the National Register and the appropriate mitigative measures are made by the Department of the Interior and the Advisory Council on Historic Preservation in consultation with the State Historic Preservation Officer. USEPA has the responsibility to ensure adequate protection, either through preservation or mitigation, of those properties included in or eligible for the National Register that would be affected by the proposed undertaking. USEPA's responsibility can be fulfilled through the promulgation of a Memorandum of Agreement between USEPA, the grantee, the State Historic Preservation Officer, and the Advisory Council on Historic Preservation as specified in 36 CFR 800.

3.2.8.2 Historic Cultural Resources

St. Charles is one of the oldest communities in Missouri. It was established in 1769 by Louis Blanchette and was known initially as Les Petites Cotes or Little Hills (Foley 1971). In 1799, Francois Saucier established a community at Portage Des Sioux (Foley 1971). Both communities had populations composed primarily of hunters and trappers.

During the early 1800's, conflicts between settlers and Native American populations escalated. In 1809, Governor Lewis ordered construction of a series of blockhouses in the district of St. Charles as a deterrent to hostile action (Foley 1971). By 1820, Native American populations in the area had been displaced or decimated by either disease or armed conflict; it was concluded that they presented, "... no significant barrier to settlement in the new State." (McCandless 1972). Native American groups in Missouri included the Osage, Sacs, Foxes, Missouris, Iowas, Kansas, and some transient groups such as the Shawnee, Delaware and Kickapoos (Mc Candless 1972).

After the Louisiana Purchase in 1803, the flow of immigrants into Missouri increased (Parrish _et al_. 1980). The hunters and trappers of earlier days were followed by farmers. In 1820, just prior to Missouri's entrance into the Union, approximately 85% of the population reported farming as their primary economic activity (McCandless 1972). Most farms were small, essentially self-sufficient operations. In 1821, following Missouri's entrance into statehood, St. Charles served as Missouri's first capital until the establishment of Jefferson City (McCandless 1972).

The growth that followed Missouri's statehood was interrupted by the Civil War. Missouri, perhaps more so than any other state, suffered from the divisiveness that led to that conflict. Although many of the immigrants to Missouri were from the South, and hence sympathetic to slavery and seccession; many of the new settlers were foreigners who opposed slavery (McCandless 1972). Most of the slaveowners were concentrated in counties along the Mississippi and Missouri rivers in order to take advantage of the fertile, alluvial soils.

As the Civil War drew to a close, new waves of immigrants entered the state and a period of economic growth followed. The appearance and development of rail lines were an important part of economic development in the state. The rivers that had been the vital link in the region's commerce were now barriers. A railroad bridge across the Missouri River at St. Charles was completed in May 1871 (Parrish 1973). Missouri's economy diversified and manufacturing began to replace agriculture as the most important component of the economy.

In 1870, St. Louis was the third largest manufacturing center in the country (Parrish _et al_. 1980). St. Charles, due to its proximity to St. Louis and location on the Missouri River shared in this growth. The recent history of the area has been one of continued expansion and development.

3.2.8.3 Prehistoric Cultural Resources

Missouri is an area that includes the confluences of three major drainage systems (Mississippi, Missouri, and Ohio rivers) and a number of physiographic regions. Due in part to these geographic characteristics, prehistoric populations in Missouri generally were never isolated from one another and contributed greatly to the pattern of cultural development in North America (Chapman 1980). The chronology of Missouri's prehistory is presented in Table 3-34. This Table is reproduced from Chapman's The Archaeology of Missouri, I (1975). Chapman defined archaeological-physiographic region of the state. St. Charles County is in the Northeast Prairie Region.

Table 3-34. Chronology of Missouri Prehistory (from Chapman 1975).

TRADITION	PERIOD
Village Farmer	Late Mississippi A.D. 1450-1700 Early Mississippi A.D. 900-1450
Prairie-Forest Potter	Late Woodland A.D. 400-900 Middle Woodland 500 B.C.-A.D. 400 Early Woodland 1000-500 B.C.
Forager	Late Archaic 3000-1000 B.C. Middle Archaic 5000-3000 B.C. Early Archaic 7000-5000 B.C.
Hunter-Forager	Dalton 8000-7000 B.C.
Early Hunter	Paleo-Indian 12,000-8000 B.C.
Unspecialized Hunter-Gatherer	Early Man (?)-12,000 B.C.

As in most parts of North America, the earlier periods of Missouri prehistory are poorly known. The Northeast Prairie Region, though, has produced a greater number of artifacts from the Paleo-Indian Period than other parts of the state, particularly in the bluffs zones along the Missouri River as it approaches the confluence of the Mississippi River (Chapman 1975). The Paleo-Indian settlement-subsistence was organized around nomadic hunting of big game by small bands comprised of a few families (Jennings 1968).

Climatological change and demographic pressures both contributed to the change in settlement-subsistence patterns and the increasing regional variation that occurred during the Archaic Period (Jennings 1968). The Archaic Period in Missouri (7000-1000 BC) began with a broadening of subsistence activities in order to exploit a greater range of ecological niches (Chapman 1975). Although this generalized hunting-foraging subsistence pattern can be identified throughout the Archaic, adaptation to a changing climate is documented in the appearance of a number of technological innovations.

Tools for woodworking, the attatl (spearthrower), fiber fabrics and cordage, and milling stones all reflect the broader range of resources exploited by Archaic populations (Chapman 1968).

The Woodland Period in Missouri (1000 BC-900 AD), as in other parts of the eastern United States, is distinguished by the appearance of three cultural innovations: horticulture, ceramics, and mound building (Chapman 1980). These features were not adopted by all groups at the same time. Throughout most of Missouri, sites containing ceramic material generally do not date before the Middle Woodland Period (500 BC-AD 400; Chapman 1980).

It was also during the Middle Woodland Period that a regional trade network developed, that is known variously as Hopewell, Hopewellian culture, Hopewellian Interaction Sphere, as well as by other similar terms (Chapman 1980). Participation in this regional trade network has been interpreted in a number of ways including a religous cult, an economic network or an interregional political-religous organization (Chapman 1980). This network, whatever its basis, can be identified archaeologically through a number of status related objects made of exotic materials, certain mortuary practices, and ceramic styles (Chapman 1980).

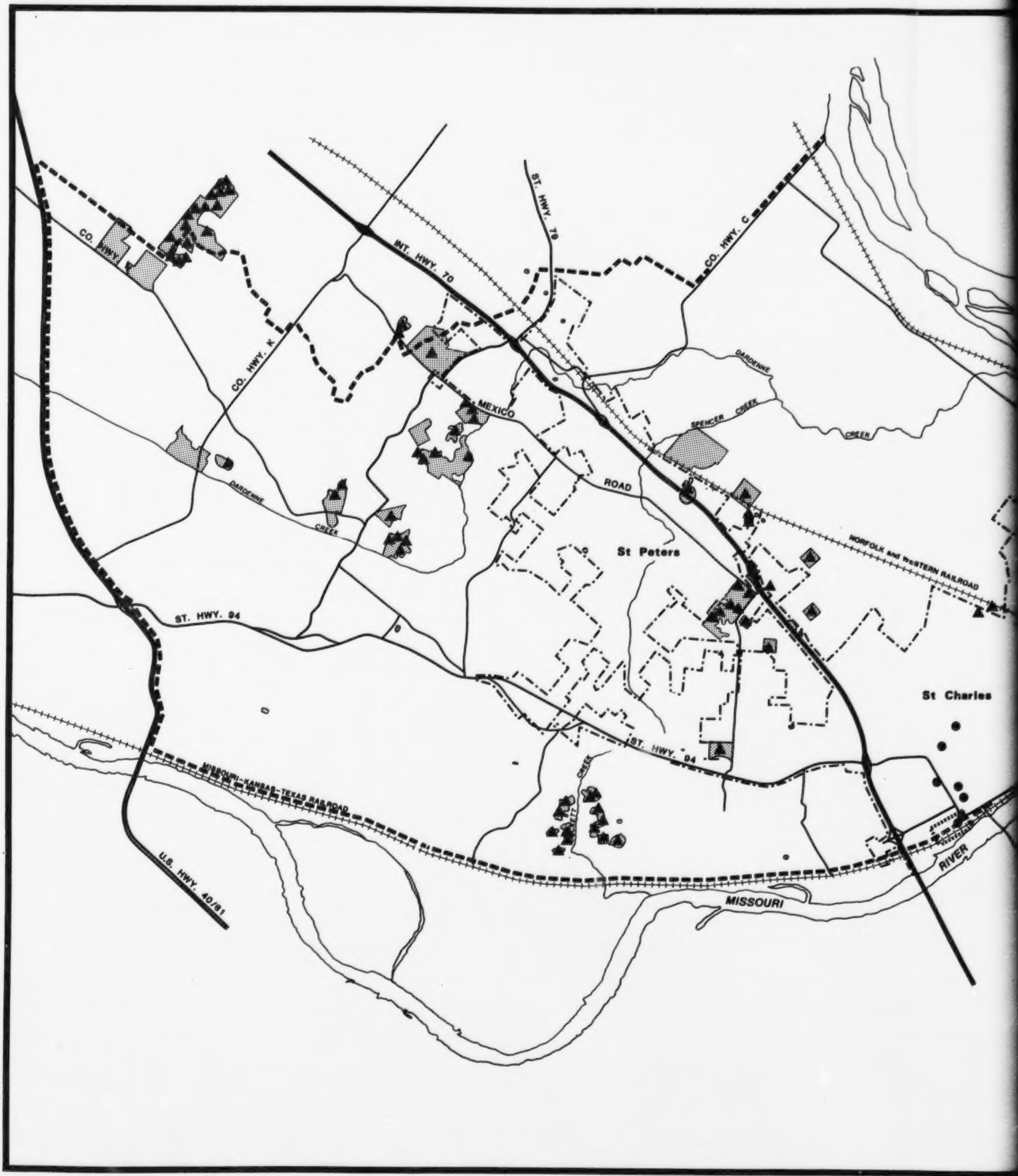
The Hopewellian Interaction Sphere apparently collapsed during the Late Woodland Period. The termination of this interregional network is reflected in changes in ceramic styles, burial practices, and a shift away from gardening and specialized exploration of resources to a more generalized hunting and gathering subsistence pattern (Chapman 1980).

The Mississippi Period that followed the Woodland Period saw the development of a subsistence pattern based on riverine farming and exploitation of a broad range of floral and faunal species. The largest center for development during this period was in the American Bottoms (Cahokia) and in St. Louis, southeast and south of the planning area (Chapman 1980). Populations during the Mississippi Period lived in permanent villages that often included fortifications and mounds arranged around a central plaza. Exchange networks of both religous and secular objects developed during this period (Chapman 1980). Despite its proximity to two major centers of development, there are no reported large Mississippi Period sites in the area north of the Missouri River (Chapman 1980). This area includes St. Charles County.

3.2.8.4 National Register Properties in St. Charles County and Potential for Other Cultural Resources

Most National Register properties in St. Charles County are within the community of St. Charles. All National Register properties in St. Charles County are historic sites, structures, or districts. No prehistoric sites in St. Charles County are currently listed on the National Register. The areas that have been surveyed for archaeological sites within the planning area, and the general location of doumented sites, are depicted in Figure 3-11. The National Register Properties in St. Charles County are listed below:

- African Church, St. Charles
- Daniel Boone House, Defiance (outside planning area)
- Daniel Boone Hays House, Defiance (outside planning area)
- First Missouri State Capitol Buildings, St. Charles
- Martin-Becker House, St. Charles
- Newbill-McElhiney House, St. Charles
- Old City Hall, St. Charles
- St. Charles Historic District, St. Charles
- Sibley Hall, Lindenwood College, St. Charles
- Stone Row, St. Charles
- Dr. John H. Stumberg House, St. Charles
- Samuel Stewart Watson House, St. Charles


CO. HWY.
INT. HWY. 70
ST. HWY. 79
CO. HWY. C
CO. HWY. K
MEXICO
ROAD
DARDENNE
SPENCER CREEK
CREEK
DARDENNE
CREEK
St Peters
NORFOLK and WESTERN RAILROAD
ST. HWY. 94
St Charles
ST. HWY. 94
CREEK
MISSOURI-KANSAS-TEXAS RAILROAD
U.S. HWY. 40/61
MISSOURI
RIVER

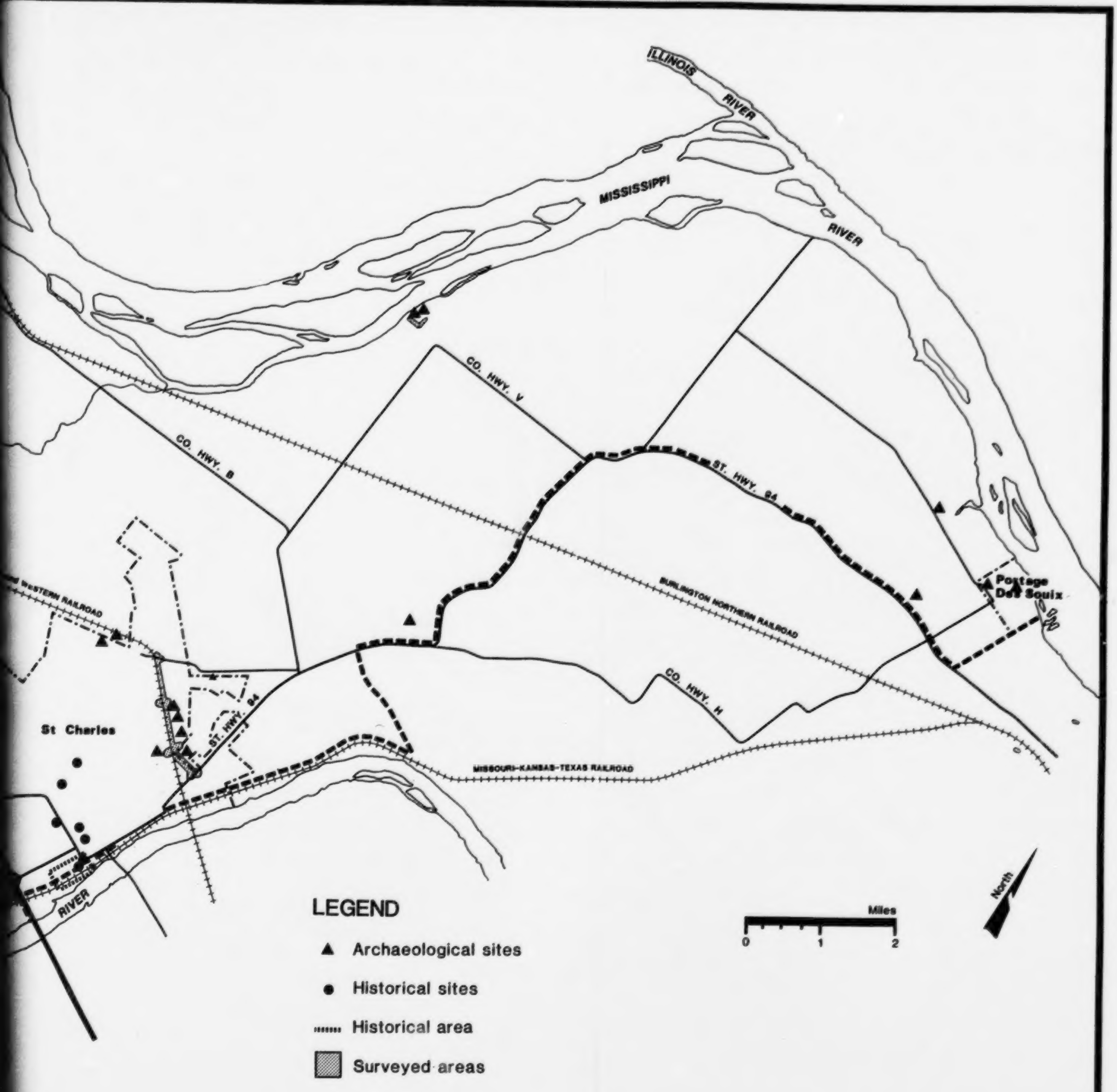

ILLINOIS RIVER
MISSISSIPPI RIVER
CO. HWY. V
CO. HWY. B
ST. HWY. 94
BURLINGTON NORTHERN RAILROAD
WESTERN RAILROAD
Portage Des Souix
CO. HWY. H
St Charles
ST. HWY. 94
MISSOURI-KANSAS-TEXAS RAILROAD
RIVER
LEGEND
▲ Archaeological sites
● Historical sites
Historical area
▨ Surveyed areas
Miles
0
1
2
North

Figure 3-11.
Archaeological and historic sites.

A review of the planning area's prehistory and history indicates that certain areas have good potential for containing archaeological and historic sites or structures. In their comparative study of the prehistoric resources of the Femme Osage and Dardenne Creek drainages, Kling and Martin (1979) note that the density of sites increases in the lower reaches of the drainage basin due to variability in soil conditions and water resources. A number of Paleo-Indian sites have been found in Missouri on terraces and bluffs adjacent to stream channels and floodplains. These kinds of features are present in the planning area. Black sand complex sites from the Early Woodland Period are often found on the low sand ridges formed on the shoreline of extinct river channels (Chapman 1980). It is possible that interceptor sewers may traverse such areas and thus impact sites of this type. Historic sites or structures that may be present in the planning area include farmsteads with domestic structures and associated outbuildings, as well as sites that are significant due to their architectural characteristics or association with historic events or persons.

3.2.8.5 Archaeological and Historic Sites in the Project Area

Recent archaeological investigations in an area that is adjacent and environmentally similiar to the planning area indicated the possibility of identifying a broad range of cultural resources (Table 3-35). Cultural resource investigations in the American Bottom, southeast of the planning area, reveal not only a complete continuum of archaeological material but also problems associated with recent impacts of urban growth and expansion on sites (Porter 1981). A similar situation was found in the planning area. Avoidance of adverse impacts on cultural resources will require the development of a well organized management plan.

Three prehistoric sites and one multicomponent site were located during the survey. Further testing will be necessary to determine their eligibility for nomination to the National Register of Historic Places. One of the historic structures present at the multicomponent site may be architecturally significant. Portions of two sites are within the 100-foot wide alignment covered by the survey. These areas may be directly impacted by construction. It is recommended that the site areas be avoided during construction.

Table 3-35. Summary of recorded archaeological sites in the planning area by period and investigator.

	Paleo-Indian	Dalton	Early Archaic	Middle Archaic	Late Archaic	Early Woodland	Middle Woodland	Late Woodland	Mississi-pian	Archaic	Woodland	Historic	Multi Component	Unident-ified	Total
Browman 1980	-	-	-	-	-	-	-	-	-	-	-	1	-	3	4
Crampton 1980a	-	-	-	-	-	-	-	-	-	-	-	1	1	-	2
Crampton 1980b	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2
King and Martin 1979	-	-	2	5	5	4	5	3	-	-	-	-	-	-	24
Miller and Shopland 1979	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Nixon and Hamilton[1] 1982a	-	-	2	1	-	-	-	2	-	2	1	2	4	27	41
Nixon and Hamilton[1] 1982b	-	-	-	2	-	1	1	1	-	2	1	4	5	25	42
Sturdevant 1980	-	-	-	-	-	-	1	1	-	-	-	-	-	10	12
Sturdevant 1981	3	-	-	1	-	-	3	4	5	-	-	-	-	14	30
TOTAL	3	-	4	9	5	5	10	11	5	4	3	8	10	81	158

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[1] Includes sites from outside planning area, identified through literature search by Nixon and Hamilton.

Prehistoric resources were found at all four sites -- 23SC604, 23SC605, 23SC606, and 23SC607. Each site consisted of surface scatters of lithic material. Site 23SC605 is a dense lithic scatter on the bluff above the Missouri River, while site 23SC607 is a small, low density lithic scatter on the slope of Taylor's Branch. Site 23SC606 has a low density of prehistoric material in association with historic ceramics and structures, on the slopes above Taylor's Branch. Site 23SC604 was found on a low rise in the floodplain of Dardenne Creek.

The historic component of Site 23SC606 includes a number of structures in addition to a surface scatter of historic ceramics. Among these structures is a double pen log house with additional rooms built by a technique known as "horizontal nogging". There are also two hand-dug, fieldstone lined wells present at the site. The historic component of the site is not within the proposed right-of-way.

4.0 ENVIRONMENTAL CONSEQUENCES

The potential environmental consequences of the wastewater management alternatives (Section 2.0) are discussed in the following sections. The impacts resulting from the construction and operation of the alternatives for each of the communities may be beneficial or adverse, and may vary in duration (either short-term or long-term) and significance.

Environmental effects are classified as either primary or secondary impacts. Primary impacts result directly from the construction and/or operation of the proposed project. Short-term primary impacts generally occur during construction. Long-term primary impacts occur throughout the life of the project and generally result from the operation of the proposed facilities.

Secondary impacts are the indirect effects of the project and occur principally from changes in population and land use that in turn induce other actions or effects that would not have taken place in the absence of the project. For example, improved or expanded wastewater treatment systems can make land available for urban development that otherwise would not have been available. This residential, commercial, or industrial development could create an increased demand for other public facilities and services; increase development pressure on agricultural lands, woodlands, or other environmentally sensitive areas; increase ambient noise levels; lead to air and water pollution; or displace low and moderate income families. Secondary or indirect impacts also may be either short-term or long-term. Short-term secondary impacts, for example, would include the disruption of the environment that occurs during the construction of the support developments that are induced by the proposed project. An example of a long-term secondary impact would be the urban runoff that occurs indefinitely following the induced development of agricultural land or open space areas.

Most adverse impacts can be mitigated, and many should be of short duration. The possible mitigative measures outlined in the following sections include planning activities and the utilization of construction techniques that reduce the severity of both primary and secondary adverse impacts. Construction plans and specifications developed by the facilities planner for the communities and reviewed by the MDNR, must include mitigative measures if Federal monies are used to assist in financing the proposed project.

4.1 Primary Impacts of No Action Alternative

Failure to implement a sound wastewater facilities plan in the Duckett Creek planning area would result in several undesirable consequences. Existing wastewater treatment and transmission facilities that are already overloaded would receive even more wastewater in the future. As a result, the bypassing or discharge of untreated or partially treated sewage directly into streams would increase, with a corresponding degradation of water quality. Pump stations and interceptor lines would become increasingly inadequate to handle wastewater flows, causing backups into basements resulting in property damage and public health hazards. If the municipalities and sewer districts are left without a well-defined program for facility upgrading with State and Federal financial assistance, most plant improvements would likely be "stop-gap" actions to resolve an immediate problem and would not represent a comprehensive, cost-effective, long-term solution to the needs of the community or to the goal of water quality improvement in the planning area.

Under the No Action Alternative, construction impacts to soils and geology would not occur since no new construction of facilities and sewer lines would take place. The existing facilities would continue to operate as they do now. Urbanization in areas which rely upon onsite systems would cause continued problems where soils have limited suitability and groundwater is shallow. Onsite system failures would continue to occur and the potential for groundwater contamination would still exist. Additionally, the increased lot sizes which would be necessary for individual onsite systems could result in inefficient land use development and affect planned residential growth.

If No Action is taken, two other situations potentially would occur that could affect soils: (1) sewage collection lines would overflow; and (2) excess, undigested sludge that could not be dried on existing sludge drying beds would be disposed potentially by landfilling and/or surface landspreading in other areas. Sewage that overflows existing collection lines potentially would either run down streets and through storm sewers to streams and other natural drainage channels, or would run in sheet flow across natural ground toward creeks and drainage ways. Raw sewage running across the surface of the ground could result in increased concentrations of organic solids, inorganic solids, and heavy metals in the surface soils; however, these increases should be minimal. Leachate from undigested sludge spread or stockpiled on the surface also potentially could contaminate soils. However, since the specific locations at which overflows and landfilling or landspreading operations would occur as a result of taking No Action currently cannot be determined, site-specific effects on soils due to overflows and sludge disposal practices cannot be identified.

As noted in Section 1.0, the facility planning area has been sustaining significant population growth for several years, which should continue. Existing centralized and onsite collection systems are inadequate for current population demand. Without development of an expanded centralized collection and treatment system, further population growth in the area would probably rely heavily on onsite systems. There are limitations relative to the use of onsite systems over much of the planning area due to the poor hydraulic characteristics of the soil. Increased partially treated onsite system effluents, either as continuous or as non-point source runoff, especially following rainfall events, would further degrade surface water quality caused by urban runoff. Surface water contamination would increase as well as the potential for public health hazards from contact with, or ingestion of, water containing harmful bacteria and/or other pathogens. Assuming growth will occur, the current wastewater management problems would be exacerbated under the No Action Alternative.

The potential for groundwater contamination would continue to exist and would increase in floodplain areas due to the failure of onsite systems due to soil limitations and high water tables. The failing septic systems and alluvial aquifer wells pose the potential for health hazards. At present, this potential is slight, but continued use of existing alluvial wells and increased pumping due to population growth could increase health risks. The same potential problems exist in upland portions of the planning area that are unsewered and have failing onsite septic systems. Where soils are not suitable for onsite systems and discharge of untreated or partially treated waste occurs to surface areas and streams, a potential for health risks due to contamination of private drinking water supplies is created.

Leaky sewer pipes and collection systems that pass through floodplain areas and alluvial aquifers also have a potential for contaminating groundwater. If wells are located nearby, a health problem could occur. The prevention of system failures includes proper planning and construction techniques. Soils in the planning area where onsite systems are prevalent have limited suitability for septic uses. The soils generally have slow permeabilities, shallow depths, and high water tables. Treatment methods for these areas could include (see Section 2.2.2.6) localized collection and treatment systems, cluster systems, and mound systems. Proper construction and design of any new individual systems and multi-family systems is essential. Formation of local sanitary districts and regulatory agencies for onsite systems should be considered, as well as educational programs and water conservation techniques.

Effects to terrestrial biota due to No Action would be expected to be minimal. Some vegetation cover may be damaged as sewage overflows the present collection system onto adjacent areas, and wildlife and domestic animals may incur some harm from coming in contact with raw or partially treated sewage.

Whereas less land would be disturbed from STP and sewer line construction under the No Action Alternative, fewer land cover types and wildlife species would be adversely affected. The existing low effluent quality being discharged into area streams and rivers would be further degraded downstream of the existing STPs. Because many of the organisms occurring in segments of the smaller tributary streams such as Dardenne Creek are pollution tolerant, the net effect should be minimal, although effects potentially would extend farther downstream into the Missouri River and Mississippi River as pollution becomes more widespread.

Under the No Action Alternative, the existing STPs (especially, Duckett Creek and Missouri River) would become more overloaded and the wastewater and sludge would not receive adequate treatment. This condition would increase the potential for aerosols generated at the existing STPs to contain pathogenic organisms, which could cause an increase of airborne diseases in plant workers and private citizens residing nearby. There also would be a slight decrease in fugitive dust emissions from the drying beds since sludge would not remain on the beds long enough to be dried thoroughly.

If No Action is taken, STP construction/expansion and operational impacts to cultural resources would not occur; however, cultural resources in the planning area still would be subject to natural processes of destruction i.e., from erosion and deterioration, as well as possible disturbance from other forms of development.

4.2 Primary Impacts of Action Alternatives

4.2.1 Construction Impacts

All four of the final action alternatives evaluated in the facilities plan require some construction including new interceptor lines and expansion of existing wastewater treatment systems. The construction impacts associated with the action alternatives analyzed in the facilities plan are addressed in the following subsections for major natural and man-made resources. Due to the similarity among the four action alternatives, the impacts discussed apply to all of the alternatives except where specific differences are noted.

4.2.1.1 Atmosphere

The construction activities associated with the four action alternatives, including placement of conveyance lines and expansion of WWTFs, would produce short-term adverse impacts to local air quality. Clearing, grading, excavating, backfilling, and related construction activities would generate fugitive dust, noise, and odors. Emission of fumes and noise from construction equipment would be a temporary nuisance to residents living near the construction sites; however, the existing STPs are not located in densely populated areas. The proposed interceptor routes primarily follow stream courses through farmland. Therefore, construction impacts are expected to be temporary and affect only a small portion of the population of the planning area.

4.2.1.2 Soil Erosion and Sedimentation

Soils exposed during construction would be subjected to accelerated erosion until the soil surface is protected by revegetation or other means of mitigating soil erosion. Proposed interceptor routes generally parallel stream channels and road rights-of-way. Runoff from construction sites would tend to concentrate in agricultural fields, stream channels, and roadside drainageways. The adverse impacts resulting from construction related erosion and sedimentation include nutrient and other pollutant inputs to streams; possible crop damage, and interruption of agricultural activities; possible siltation, clogging of road culverts, localized flooding where drainageways are filled with sediment, and damage to structures, roads, and ditches.

Erosion can be controlled and held to a minimum if proper techniques and methods are employed. Controlling erosion involves minimizing soil exposure during construction, controlling surface runoff, and shielding and binding the soil immediately following construction. Minimizing soil exposure during digging and trenching operations will control the major potential for erosion. Grading and revegetating areas concurrently with construction will reduce erosion potential to a minimum. Controlling surface runoff is accomplished by intercepting and diverting runoff from areas under construction. Diversion structures, such as dikes, ditches, and terraces should be placed to route runoff away from exposed soils. Shielding and binding soils involves revegetating soils, covering with non-vegetative shields such as pavement, rip-rap, netting, or using chemical binders such as soil cement to lower the erosion potential immediately after construction.

Sedimentation is a direct result of erosion. Complete erosion control is impossible, as some erosion will always occur when soils are disturbed by construction. Proper control of erosion lowers the potential for sedimentation problems. Sedimentation can be controlled by installing buffers or filters in the form of hay bales, vegetation, gravel traps, or fabric filters in areas where runoff carries large amounts of sediment. The best sediment control practice is a good erosion control plan.

Most soils in the planning area have been classified by the Soil Conservation Service as having slight to slight-moderate erosion hazard ratings

(Section 3.1.2.2). Only those soils occurring on steep slopes (Crider, Harvester, and Menfro soils) are classified as having moderate-severe ratings. Further, most soils in the planning area are classified as having low to high shrink-swell potentials. Some problems could be encountered during and after construction if construction methods do not consider this soil characteristic. Volumetric changes in some soils also could occur during changing water levels. This would primarily affect sewer lines. Excavation in the planning area should not be difficult although some bedrock may be encountered in the upland areas. High water tables could also cause construction problems.

4.2.1.3 Surface Water

Increased sedimentation resulting from the construction of wastewater collection lines could result in degradation of surface water quality, as noted above. The surface water quality impacts associated with the construction of sewer lines - increased nutrient inputs, increased turbidity, possible siltation - would occur under all action alternatives. However, construction impacts would vary in intensity and duration depending on the extent of rainfall during construction, length of the sewer lines, placement of lines in relation to drainageways, and the effectiveness of mitigative measures used to reduce runoff and sedimentation. These factors will influence the amount of runoff and sediment that reaches surface waters, and ultimately, the severity of the surface water impacts during construction.

Alternatives 3, 6, 7, and 8 all recommend abandonment of the Harvester-Dardenne STP, with wastewater being pumped to other facilities for treatment. Although the implementation of any of these alternatives would reduce the flow of water in upper Dardenne Creek, water quality (specifically DO and TSS) in Dardenne Creek should improve immediately since dissolved oxygen demand and fecal coliform loadings would decline significantly.

4.2.1.4 Groundwater

Groundwater may be impacted by construction activities in localized areas under all action alternatives. Construction dewatering may cause some shallow wells to fail, especially where pump stations are to be constructed. A potential change in water quality would likely occur where organic soils are disturbed either directly or by altering the water table. Organics may leach out of these areas and affect the taste of water in nearby wells. Spilled fuel and other construction materials could percolate through some soils to contaminate the groundwater. Although impacts to the groundwater system in the planning area due to construction of action alternatives should be minimal, the water table in the alluvial floodplain areas is shallow and soils are permeable. Therefore, construction in these areas presents the highest potential for groundwater contamination if proper construction techniques are not followed. Runoff from construction sites also could enter the groundwater system if not propertly controlled. Groundwater flow and quantity should not be adversely affected during construction activities.

4.2.1.5 Biological Resources

Construction activities associated with various components of the proposed action alternatives would result in impacts to terrestrial and aquatic biota to varying extents. Construction of interceptor lines would result in temporary losses of vegetated areas during initial earth moving operations. Disruption of backyard vegetation and the presence of construction equipment and noises would cause temporary displacement of most vertebrate species and mortality of a few of the smaller, less mobile species. Revegetation and cessation of construction activities would allow re-establishment of animals in disturbed areas. Animals most commonly displaced would be those associated with human habitation (e.g., eastern cottontail rabbits, house sparrows, starlings, etc.). Most of these animals would relocate in adjacent habitat.

Proposed sewers and force mains generally parallel and are contiguous to existing road rights-of-way and stream corridors. A strip of approximately 20 feet of roadside vegetation would be removed during construction along county road rights-of-way, and a strip of approximately 20 to 40 feet would be disrupted for placement of force mains. This could disrupt hedge row/fencerow vegetation and associated animal life in both residential and agricultural portions of the planning area.

The dominant land cover types along the proposed wastewater collection lines are residential, commercial, and agricultural. Small woodlots border the routes at scattered locations; second-growth roadside shrub vegetation would likely be destroyed. Birds, mammals, reptiles, and amphibians that reside on or near the proposed routes should relocate in adjacent areas during construction. Less mobile animals would incur some mortality from construction. Displacement of most animals would be temporary.

All construction activities in the Mississippi River floodplain should be planned and conducted to prevent disruption of migratory waterfowl feeding, resting, and roosting areas. The major migratory period occurs from August through December, and March through April.

Construction activities associated with proposed wastewater treatment plant improvements would destroy minimal acreage of natural vegetation. The impacts to native terrestrial biota resulting from upgrading of existing treatment systems would be insignificant since relatively small acreages of undeveloped land would be required.

During construction, erosion would cause sedimentation and turbidity and result in a short-term decrease in aquatic productivity in some stream segments near water collection line construction, especially along new rights-of-way. The quantities of sediment entering streams would vary depending on the duration and magnitude of storm events occurring during the construction period. Severe erosion and sedimentation resulting in major impacts to aquatic biota from sewer line construction are not expected. Adverse impacts from erosion and sedimentation must be mitigated by using sedimentation ponds and/or other erosion prevention techniques (hay, mats, etc.), and specific mitigative measures may be stipulated in construction permits and grant awards. Depending on which alternative is finally implemented, Duckett Creek, Spencer Creek, and/or Dardenne Creek, downstream from proposed STP modifications, would receive increased sediments/turbidity during plant expansion. However, effects to aquatic life are expected to be temporary and insignificant. Mitigation measures can be taken as discussed above to lessen impacts from sedimentation.

4.2.1.6 Wetlands and Floodplains

Construction of new sewer lines for collection and conveyance of wastewater along existing and new corridors for all action alternatives would result in temporary disturbance of some floodplains soils and vegetation. The extent of damage is expected to be minimal, and little or no effect is expected on the floodplains' potential for dispersal of flood waters. Affected wetland acreages are insignificant. Although the overall effect of construction on floodplains would be minimal, there are some differences among the four final action alternatives. Alternative 3 would affect the fewest acres of floodplain, since most of the construction would occur only in the lower Dardenne Creek Area along the Mississippi River floodplain. In Alternative 6, disturbances in addition to those described in Alternative 3, would occur along Duckett Creek in the Missouri River floodplain. In Alternative 7, the disturbance to floodplains along the Missouri River would be similar to Alternative 6. Disturbances would also be expected under Alternative 7 to Mississippi River floodplain areas. More disturbances would occur along the lower reaches of Dardenne Creek under Alternative 7 than in Alternatives 3 and 6. Floodplain areas affected by Alternative 8 include the Mississippi River floodplains along lower Dardenne Creek (similar to Alternatives 3 and 6) and the Missouri River floodplain along lower Duckett Creek (similar to Alternatives 6 and 7.

4.2.1.7 Land Use

Expansion of existing STPs under all action alternatives would not require purchase of additional land outside present plant boundaries. Construction of new facilities at the plants is not expected to affect or change existing land use in the immediate vicinity of the STPs. It is possible, however, that current land use and certain future land uses potentially could be affected, to an unknown extent, by increasing treatment capacities or abandoning treatment facilities.

Proposed interceptor routes parallel stream courses and/or road rights-of-way. These proposed routes are predominantly in areas used for agriculture or low density residential development. Construction impacts would include crop damage, disruption of farm operations, and compacting of soils during construction and backfill activities.

4.2.1.8 Demography

Jobs created directly by construction of wastewater collection and treatment facilities are not likely to attract any new permanent residents to the planning area. These temporary construction jobs would probably be filled by workers from the St. Louis metropolitan area, therefore no significant demographic impacts are anticipated during the construction of proposed wastewater management facilities.

4.2.1.9 Prime and Unique Farmlands

Some additional land (about 10 acres) is required for expansion of the Duckett Creek STP, but it is not expected to significantly affect existing farmlands; however, farmlands would be affected by construction of new pipelines for collection and conveyance of sewage. Construction of pipelines would temporarily remove farmlands from agricultural uses. The only long-term impact may be compaction of soils from backfilling and movement of heavy equipment across fields. Pipeline rights-of-way are narrow and generally along the perimeter of fields, therefore, impacts on farmlands are expected to be insignificant.

4.2.1.10 Economics/Public Services

The construction activities associated with the action alternatives would create a limited number of short-term construction jobs. Most jobs would be filled by persons living within the planning area or within a reasonable commuting distance of the area. The purchase of construction materials from merchants within the planning area would benefit the local economy. Firms offering the necessary building materials are present within the St. Louis metropolitan area. Disruption of public services, if any, should be minor and of short duration during construction.

4.2.1.11 Transportation

Increased truck traffic during the construction of centralized wastewater collection and treatment systems would increase traffic congestion and disrupt traffic flows, particularly in urban areas. Temporary road closures during excavation, grading, and backfilling along roadways would modify vehicular traffic patterns and inconvenience motorists. The temporary closure of some roads also would inconvenience permanent residents and result in increased traffic congestion on adjacent roadways.

4.2.1.12 Energy Resources

Residential, commercial, and industrial energy requirements are not likely to be affected during the construction of the proposed wastewater collection and treatment facilities. Trucks and equipment used for the construction of wastewater treatment facilities would increase demand temporarily for local supplies of gasoline and diesel fuel. The increased demands resulting from construction activities are not anticipated to have a significant impact on the short-term or long-term availability of fossil fuels in the planning area.

4.2.1.13 Cultural Resources

No known cultural resources would be affected by expansion of the existing STPs. Proposed rights-of-way for collection and conveyance of new sewers were examined for prehistoric, historic, and architectural resources. Three prehistoric sites and one multicomponent site were located within or adjacent to proposed interceptor line rights-of-way. Further testing would be necessary to determine their eligibility for nomination to the National Register of Historic Places. One of the historic structures present at the multicomponent site may be architecturally significant. Portions of two sites are within the 100-foot wide alignment. These areas may be directly impacted by construction activities.

4.2.2 Operation Impacts

Each of the alternatives, including the No Action alternative, includes operations that would continue through the 20-year project planning period. Included in the definition of operations is expansion of existing STPs, and construction of pumping stations and pipelines for collection and conveyance of sewage. Primary operation impacts associated with the alternatives for the planning area communities are addressed in this section for each of the natural and man-made environmental resource areas.

4.2.2.1 Atmosphere

Potential air emissions from the operation of each of the wastewater management alternatives are similar and include aerosols, hazardous gases, and odors. The emissions could pose a public health risk or create a nuisance.

Aerosols are defined as solid or liquid particles, ranging in size from

0.01 to 50 micrometers that are suspended in the air. These particles would be produced at the proposed wastewater treatment facilities during various treatment processes. Some of the constituents of aerosols have the potential of being pathogenic and could cause respiratory and gastrointestinal infections; however, concentrations of bacteria or viruses in aerosols are generally insignificant (Hickey and Reist 1975). The majority of the microorganisms in aerosols are destroyed by solar radiation, desiccation (drying out), and other environmental phenomena. There are no records of disease outbreaks resulting from pathogens present in aerosols. Therefore, no significant adverse impacts are expected from aerosol emissions from any of the action alternatives.

Discharges of hazardous gases could have adverse effects on public health and the environment. Explosive, toxic, noxious, lachrymose (causing tears), and asphyxiating gases can be produced at wastewater treatment facilities. These gases include chlorine, methane, ammonia, hydrogen sulfide, carbon monoxide, nitrogen oxides, sulfur, and phosphorus. The knowledge of the possibility that such gases can escape from the facilities or enter work areas in dangerous or nuisance concentrations may affect the operation of the facilities and the adjacent land uses. However, gaseous emissions can be controlled by proper design, operation, and maintenance procedures.

Odor is a property of a substance that affects the sense of smell. Organic material that contains sulfur or nitrogen may be partially oxidized anaerobically and result in the emission of byproducts that may be malodorous. Common emissions, such as hydrogen sulfide and ammonia, are often referred to as sewer gases and have odors of rotten eggs and concentrated urine, respectively. Some organic acids, aldehydes, mercaptans, skatoles, indoles, and amines also may be odorous, either individually or in combination with other compounds. Sources of wastewater related odors include:

- Fresh, septic, or incompletely treated wastewater
- Screenings, grit, and skimmings containing septic or putrescible matter
- Oil, grease, fats, and soaps from food handling enterprises
- Gaseous emissions from treatment processes, manholes, wet wells, pumping stations, leaking containers, turbulent flow areas, and outfall areas

- Raw or incompletely stabilized sludge or septage.

Wastewater treatment lagoons typically emit considerable odors when the water "turns over" in the spring. These odors are likely to be noticeable for at least one-half mile down wind. Effluent odors may escape from lift stations where turbulent flows occur unless proper design steps are taken to minimize odors. The occasional failure of an onsite system also may release some odors. Septage haulers using inadequate or improperly maintained equipment may also create odor nuisances.

4.2.2.2 Soils

Since land application of effluent is not proposed as part of any of the action alternatives, the operations of existing and proposed wastewater treatment facilities, sewer lines, and ancillary facilities under the action alternatives should have minimal effects upon the soils in the planning area. However, if selected, the operation of a land application site(s) for disposal of sludge would alter the soils of these sites over the life of the project. The potential changes would depend on the existing chemical and hydraulic properties of the soil, and on the composition (e.g., metals) and application rates of the sludge. Organic constituents in the applied sludge would be oxidized by natural biological processes. The volatile solids also would be biologically oxidized and inorganic solids could become part of the soil matrix (USEPA 1981b). Design considerations for proposed sludge disposal sites (e.g., liners etc.) would serve to minimize any adverse impacts to soils.

4.2.2.3 Surface Water

Dardenne Creek

Lower Dardenne Creek is located in St. Charles County west of St. Charles, Missouri. The stream is classified for livestock and wildlife watering, aquatic life protection, and boating for 22 miles above its mouth. Dardenne Creek flows predominantly northeast and eventually empties into the Alton Pool on the Mississippi River. The lower 7 miles of Dardenne Creek are considered to be a backwater area of the Mississippi River. The soils of the area are predominantly a glacial till consisting of clay with rock and gravel intermixed and overlain by 2 to 4 feet of loess.

The lower Dardenne Creek was noted as a water quality limited stream in the 1976 "303(e)" Basin Plan. Water quality limited streams require that wastewater treatment plants employ advanced treatment in order to protect stream water quality. The basin plan cited low dissolved oxygen and high fecal coliform concentrations as problems caused by multiple wastewater discharges in the basin. There are two major municipal wastewater treatment plant discharges in the lower Dardenne Creek area. The Harvester-Dardenne STP discharges to a small unclassified tributary with flows for 0.75 of a mile before entering Dardenne Creek approximately 13.5 miles upstream from its mouth. The St. Peters wastewater treatment plant discharges to Spencer Creek which flows for 2.0 miles before entering Dardenne Creek approximately 5 miles upstream from its mouth.

Two water quality surveys were conducted jointly by the U.S. Geological Survey and the Missouri Department of Natural Resources during the summer of 1983. The purpose of these studies was to evaluate the existing water quality and to develop a stream model for Dardenne Creek to predict future water quality problems. The data indicate that there are presently water quality standards violations of both un-ionized ammonia-nitrogen and dissolved oxygen for several miles below both the Harvester-Dardenne and St. Peters (Spencer Creek) STPs. Water quality data indicated that both tributaries are severely polluted. Dissolved oxygen concentrations approached zero below the Harvester-Dardenne STP and the Harvester-Dardenne tributary had high fecal coliform concentrations in a segment that flows through a rapidly developing residential area. The last 6 miles of Dardenne Creek had a high concentration of phytoplankton, and a super saturation of dissolved oxygen due to the photosynthesis which occurs during the day.

Implementation of Alternatives 3, 6, 7, or 8 would remove the present discharge of the Harvester-Dardenne plant from the tributary of Dardenne Creek and thereby reduce the pollutant loading to the stream. Selection of the No Action Alternative would result in the continued degradation of the stream, eliminating recreational and aesthetic benefits and creating an increased public health hazard.

Spencer Creek

Discharges to Spencer Creek are primarily from the St. Peters STP. The

St. Peters STP consists of a 3.0 mgd aerated lagoon with two final clarifiers and aerobic sludge digestion. The water treatment plant discharges from lime sludge ponds and has had past problems consistently meeting their suspended solids permit limits. Spencer Creek is unclassified in the water quality standards; however, examination of the original maps from which the standards were derived revealed that it should be listed as a Class "C" stream. Therefore, the stream should be classified for aquatic life protection and livestock and wildlife watering.

Water quality modeling of Spencer Creek and the lower Dardenne Creek has shown that when secondary treatment is employed (at the St. Peters STP) under worst case drought conditions that the dissolved oxygen would be completely depleted in Dardenne Creek within 1 mile below Spencer Creek. The model predicts this would happen even at the present wastewater flow of 3.3 cfs at the St. Peters plant. There would also be a violation of the un-ionized ammonia standard below Spencer Creek. The model predicts a dissolved oxygen sag upstream of Spencer Creek due to sediment oxygen demand and background loads which are significant under these drought flow conditions. If nitrification were employed at the St. Peters STP, there would be a significant improvement in water quality by eliminating un-ionized ammonia violations. Dissolved oxygen concentrations may still fall below the standard of 5.0 mg/l; however, the predicted low dissolved oxygen concentrations should not be acutely toxic to aquatic life even at wastewater flows of up to 12.0 cfs.

Adverse effects to surface waters from the operation of the collection line system, pumping stations, and interceptor lines are expected to be minimal. Breaks or leaks in sewer lines could cause short-term pollution in isolated situations to area streams; however, these occurrences after the new collection line systems would be installed should be much less frequent than the existing transmission system. Several other effects also may be associated with sludge treatment and disposal. Dewatered sewage sludges potentially could contain measurable amounts of heavy metals and organics in addition to measurable amounts of coliform bacteria and ammonia-containing compounds (NH_3, NO_3, and organically bound nitrogen). All of these materials can adversely affect the quality of surface waters if they enter streams in sufficient quantities. Primary impacts to surface waters from land application of sludge could include degradation of water quality from erosion of soils containing sludge. This may lead in turn to increased turbidity/sedimentation, BOD, and metal buildup, and decreased dissolved oxygen concentrations in affected streams. State and Federal regulations concerning sludge application to lands should lessen these effects.

4.2.2.4 Groundwater

Operations of existing and planned centralized wastewater treatment plants, sewer lines, and ancillary facilities should have minimal impacts on groundwater resources in the planning area. Proper construction and operation procedures should minimize the potential for groundwater contamination due to spills or leakage of untreated or partially treated wastes. Primary dangers of groundwater contamination would be associated with leakage along sewer lines and around sewage lagoons, and leachate from sludge storage areas. Sewer lines in floodplain areas could pose potential problems unless properly constructed and maintained. Groundwater quality in floodplain areas and downstream from all existing treatment plants should improve due to the proposed project. Water quality in alluvial aquifers should remain high or improve with improved wastewater treatment in the planning area.

The continued use of existing onsite systems and the future use of new or rehabilitated onsite systems due to increased urbanization in the planning area has the potential to cause groundwater contamination problems in those localized areas developed in floodplains where individual alluvial wells are the source of potable water. New developments in these parts of the planning area should consider cluster systems, away from wells, where suitable, and mound systems away from wells in areas of high water levels. Increasing development in floodplain areas and development of more water supply wells as potable water sources also could cause migration of contaminants from waste treatment areas to these wells.

4.2.2.5 Biological Resources

Following construction, biological communities would re-establish along all collection line rights-of-way. Some utilization by birds and perhaps other species of wildlife would occur at the site associated with the Spencer Creek STP. Continued disturbance of plants and wildlife would occur during facilities operation due to the human population growth associated with upgrading and expanding the STPs and service area. The extent and significance would depend largely on community planners and their consideration for maintaining natural vegetation cover types.

Under Alternative 3, dissolved oxygen and total suspended solids concentrations should improve in upper Dardenne Creek and lower Harvester Creek due to the closure of the Harvester-Dardenne STP. Alternatives 6, 7, and 8 would change the Harvester-Dardenne STP to a pump station. This proposed action would also lead to improved water quality since it would eliminate discharge of effluent into Dardenne Creek. The expansion of the Duckett Creek STP identified in Alternatives 6, 7, and 8 would improve water quality downstream from the Duckett Creek facility. Upon completion of the plant modifications, the improved water quality conditions should result in an increased diversity and abundance of aquatic biota. The quality of water and aquatic biota also should improve throughout the Dardenne Creek system as water quality improves from more efficient wastewater collection systems for outlying residential areas that were previously dependent on small plants or onsite systems.

4.2.2.6 Wetlands and Floodplains

No effects from operation of any of the four final action alternatives are expected on floodplains or wetlands in the planning area.

4.2.2.7 Land Use

Land use within the rights-of-way of wastewater conveyance lines would be affected temporarily when maintenance or repairs are performed on sections of the lines. Periodic excavation and filling also would disturb vegetation and soil along conveyance lines. The release of low level odors and aerosols from STPs and the knowledge that hazardous and/or malodorous gases could potentially be released from those plants may adversely affect land uses adjacent to the facilities.

4.2.2.8 Demography

The operation and maintenance of wastewater management facilities proposed under any of the four final action alternatives would not have a significant impact on the demography of the planning area. A limited number of long-term jobs created by the operation and maintenance of these facilities likely would be filled by persons living in and around the planning area. It can be assumed that new residents would not be attracted to the planning area solely on the basis of the limited number of permanent positions created.

4.2.2.9 Economics/Public Services

The operation of expanded wastewater facilities would create a few long-term jobs. These jobs likely would be filled by persons residing in the planning area. Existing contractors are expected to satisfy local demand for construction and maintenance services for onsite systems. Therefore, no significant economic impacts are expected to occur during the operation of wastewater treatment facilities under any of the alternatives. Similarly, public services should not be affected by operation of any of the proposed action alternatives.

4.2.2.10 Transportation

Impacts arising during the construction of collection and conveyance lines would reoccur, to a lesser extent, when maintenance or repairs are required. Occasionally some roads may be closed on a temporary basis. In addition, moderate truck traffic to and from the proposed treatment facilities under all alternatives would be associated with deliveries of supplies, but would not impact the existing transportation system.

4.2.2.11 Energy

The operation of wastewater treatment facilities and pump stations under Alternatives 3, 6, 7, and 8 require the use of electricity and fossil fuels. Alternative 8 would require the greatest amount of these energy sources, while Alternative 7 would require the least. The relative ranking of alternatives by energy demand is 7 (least), 3, 6, and 8 (highest); however, no significant demands would be placed on local energy supplies under any of the alternatives.

4.2.3 Fiscal Impacts

The costs of implementing a wastewater collection and treatment project in the planning area would be apportioned between USEPA, the State of Missouri, and local residents. Apportionment of the costs would be made on the basis of what costs are eligible to be funded by the State of Missouri or USEPA. An evaluation of costs for the four final action alternatives is presented in Section 2.3.3.1. A summary of costs for the facility plan recommended system alternative is included in Section 2.3.4.6 as is the calculation of the local share of costs.

Indicators for assessing an area's financial condition in determining the magnitude of the fiscal impacts associated with wastewater collection and treatment alternatives include:

- Annual rate of change in population
- Operating surplus or deficit as a percentage of total current expenditures
- Real property tax collection rate
- Property tax revenues as a percent of full market value
- Overall debt as a percent of full market value
- Overall debt as a percent of personal income
- Overall debt outstanding per capita
- Overall debt as a percent of the statutory debt limit
- Ratio of the average annual user charge to median household income.

The data used to derive the indicator values are listed in Table 4-1. Indicator ratings are presented in Table 4-2. Two indicators (property tax revenues as a percentage of full market value, and overall debt as a percent of full market value) were not developed due to the nonavailability of full market value data.

The annual rate of change in population indicates whether or not a community is growing, stabilizing, or declining. This information is useful because an area's economic base is dependent upon personal income, market value of real property, and retail sales, which in turn depends on the size of the population. Therefore, the economic base will likely broaden with increases in population.

Table 4-1. ST. CHARLES COUNTY DATA USED TO DERIVE INDICATOR VALUES

INDICATOR	VALUES
Property Taxes	849,759
Sales Taxes	4,023,508
Other Revenue	3,040,911
Operating Expense	6,738,661
Debt Service	692,366
Property Tax Volume Ratio (%)	93%
Assessed Value	749,760,638
Ratio	19.7
Per Capita Income (1980)	$7,679
Population (1980)	144,107
Median Household Income (1980)	$22,408

(Reference: By telephone, John Nichols, County Auditor, 27 April 1984;
by telephone, Mary Grady, US Bureau of the Census,
4 April 1984.

Table 4-2. FISCAL INDICATOR RATINGS FOR ST. CHARLES COUNTY (1)

Indicator	Ratings (2) Weak	Average	Strong
• Rate of change in population			X
• Current surplus as a % of total expenditures			X
• Real property collection rate	X		
• Overall net debt as a % of personal income		X	
• Overall debt outstanding per capita			X
• Overall debt as a % of statutory limit		X	
• Ratio of average annual user fee to median household income (3) (4)			X

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(1) Indicators include local share of fiscal obligation.

(2) Ratings indicate fiscal conditions, values for each indicator are discussed in the text.

(3) Based on median household income of $22,408, excludes Floodplain Onsite Service Areas

(4) See Table 4-3 for average annual user fees by subareas.

Source: Financial Capability Guidebook

An annual rate of change below -1%, i.e., loss of population is considered a weak rating of the fiscal environment. Annual population change of a rate between -1% to +1% indicates a stable population and an average fiscal condition. An increasing population, indicated by a rate of change of +1% or more, indicates a strong fiscal condition for the county. Thus, an annual rate of population change for St. Charles County of 5.5% incicates the area is indeed experiencing positive population growth and hence, an increase in its economic base.

Another indicator of an area's financial stability is to determine current operating surplus or deficit as a percentage of total current expenditures. Data on revenues and expenditures were collected from St. Charles County. Current revenues for 1983 totaled $7,954,178 and current expenditures totaled $7,431,017. St. Charles County had a surplus of $523,151. A positive percentage above 5% indicates a healthy fiscal environment. A percentage between 0-5% indicates an average fiscal strength rating. Percentages below 0 indicate weak fiscal conditions. The current surplus for St. Charles County is equivalent to 7% of total expenditures, an indicator of a strong fiscal environment.

The real property tax collection rate is another index for estimating the potential fiscal impacts of a capital improvement project. Collection rates below 96% are considered weak. Rates from 96 to 98% are indicators of average financial strength, while rates above 98% are felt to be strong financial indicators. The rate for St. Charles County in 1983 was 93%. The weakness here is more than offset by the other positive indicator ratios.

Property tax revenues as a percent of full market value indicates the potential for future revenue growth from this source. A high ratio implies fiscal pressure in the area because growth in property tax revenues would not be feasible, that is, unless a parallel increase in property values was also occurring. Four percent or more is considered to be a high ratio, 2-4% is average, and less than 2% is a low ratio. St. Charles has a low rate (.02%) which is considered a strong indicator.

The debt capacity of an area can be calculated when overall debt is considered as a percentage of full market value of real property as well as personal income. It is also calculated per capita. Overall debt as a percent of full market value of real property calculates an area's ability to support additional borrowing. A strong indicator would have a rating below 3%. St. Charles' rating of 0.2% signifies that St. Charles could indeed support additional borrowing without incurring negative impacts.

Another indicator of an area's fiscal stability is personal income which can also be used to assess the area's ability to repay debt. If overall net debt exceeds 12% of personal income, fiscal strength is considered to be weak. An overall net debt to personal income percentage from 4 to 12% indicates average fiscal health. A percentage below 4% is an indicator of a strong fiscal condition. Taking overall debt as a percentage of a personal income results in a rate of 8.68% for St. Charles County, an average rating.

Taking overall debt and dividing by current population is a guage of the burden on the community of the general obligation debt. Indicator ratings for weak, average, and strong fiscal conditions are more than $1,000, between $450-1,000, and less than $450, respectively. The result is an indicator value of $52, for St. Charles County, which represents a strong fiscal rating.

These last three indicators do not take into account the local share of the facilities plan recommended alternative. When local share is considered, these values change to 1%, 3.5%, and $266, respectively which are still strong indicators of an area's financial capabilities.

Another index for estimating the potential fiscal impacts of a capital improvement project is the level of overall debt (existing debt combined with capital costs of the project) as a percentage of the statutory debt limit. Low fiscal strength is indicated by an overall debt above 90% of the statutory limit. An overall debt from 40 to 90% of the statutory limit indicates average fiscal strength, while a value below 40% indicates high fiscal strength. In general, if an area's overall debt exceeds 90% of the statutory debt limit, its ability to undertake other capital improvement projects in the near future could be jeopardized. Communities financing projects that would cause the overall debt to exceed this 90% guideline can generally expect to pay a higher interest rate on general obligation or revenue bonds (St. Charles County has general obligation bonds only) that are sold to finance the project. Overall debt as a percentage of the statutory limit is calculated for St. Charles County as follows:

Total Debt*	Statutory Debt Limit	Overall Debt as a % of Limit (Debt/Limit x 100)
$30,848,500	$74,976,064	41.1

* Total debt includes existing debt (which is the outstanding debt for St. Charles) plus local share of the costs.

As the figure indicates, the 90% guideline would not be exceeded, thus implementation of the facilities plan recommended alternative would not limit the implementation of other capital improvement projects.

Finally, the ratio of the average annual user charge to median household income is used as an index to ascertain the impact that user charges would have on a household. The USEPA considers projects to be expensive, and as having an adverse impact when annual user costs per household exceed the percentages of median household income listed below:

- 1.0% of median household income less than $10,000
- 1.5% of median household incomes between $10,000 and $17,000
- 1.75% of median household incomes greater than $17,000.

Median household income for St. Charles County was $22,408 in 1980 (By telephone, Steve Laue, Bureau of the Census, 20 April 1984). This figure is 33% higher than the national figure and 44% higher than the state figure. Using the median income for St. Charles County, a ratio of average annual user costs to median household income is presented in Table 4-3. As the data in Table 4-3 indicate, implementation of the facilities plan recommended alternative would not impose a significant financial burden on users. The City of Portage Des Sioux would marginally exceed the limit recommended by USEPA in 1985 only; however, if the North area and Northeast area transmission system projects are not constructed, an adverse impact on the finances of the users would not occur.

Table 4-3. ESTIMATED AVERAGE ANNUAL USER COSTS AS A PERCENTAGE OF MEDIAN HOUSEHOLD INCOME..

Sewer Service Area	Annual User Costs[d]		Median Household Income (1980)[a]	User/Cost Median Household	
	1985	2005		1985	2005
Duckett Creek	$120	$116	$22,408	.53	.52
St. Charles	96	80	22,408	.43	.36
St. Peters	50	79	22,408	.22	.35
City of Portage Des Sioux	281	348	18,374[c]	1.53	1.89
	242[b]	266[b]	18,374[c]	1.32	1.45
*Floodplain Onsite System Areas	676	676	22,408	3.02	

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[a] Median household income for St. Charles County

[b] User charges, if North area and Northeast area transmission system projects are not constructed, are estimated at $242/year for 1985 and $266/year for 2005.

[c] Source: East-West Gateway Coordinating Council.

[d] Source: Sverdrup & Parcel and Associates, Inc. (1984).

*Determined not to be implementable and thus eliminated from facilities plan recommended alternative.

Overall, the indicators from the fiscal analysis are positive. Implementation of the facility plan recommended alternative would not impose a significant financial burden on residents in the service areas. This is suggested by a high growth rate, relatively high income levels, a relatively young population which suggests fewer people on fixed incomes (6% of residents are over 65 years old in St. Charles County compared to the state percentage of 13.2%), and commercial growth in the area.

4.3 Secondary Impacts of the No Action Alternative

As discussed in Section 4.1, St. Charles County is an area that has undergone significant and rapid population growth in recent years. This growth pattern, although it has slowed somewhat, is anticipated to continue. Some of the wastewater treatment facilities in the planning area currently have difficulties in meeting the effluent limitations specified by their NPDES permits because of hydraulic overloads, system deterioration, and related factors. Some portions of the county currently served by onsite wastewater treatment systems are not providing an adequate level of treatment to safeguard public health. As population density in the area increases, these problems would worsen and there would be additional non-point source pollution from increased runoff from developed areas which would further contribute to degradation of surface water quality. Without expansion of the centralized wastewater treatment and collection systems, growth in the planning area would be inhibited and/or would tend to be less orderly and more dispersed.

4.4 Secondary Impacts of Action Alternatives

Each of the action alternatives would have effects that extend beyond primary construction and operational impacts. These indirect, or secondary impacts are likely to occur when improvements in wastewater treatment capacity and capability lead to land use and/or population changes in the planning area that, in turn, induce or stimulate other developments which would not have taken place in the absence of the proposed project. The principal resource areas that may experience significant secondary impacts are described in the following sections.

4.4.1 Demographics

Population growth and land development have always been dependent on factors such as transportation access, employment opportunities, physical setting, and land values. One of the more significant factors influencing the development potential of an area is the presence or absence of adequate centralized wastewater collection and treatment systems. Onsite wastewater treatment facilities often limit development to areas with suitable soil and site characteristics, while centralized sewer systems allow greater locational independence because soil, slope, and drainage are less constraining design parameters. The construction of sewers in an unsewered area often increases the supply of buildable land, and local municipal ordinances usually allow development at greater densities in sewered areas than in unsewered areas.

In some situations, improvements in wastewater treatment capacity and capability can induce, or stimulate growth that would not have occurred without the improvements. Typically, such induced growth occurs in areas where there is significant demand for residential development, but demand is constrained by the lack of adequate wastewater treatment capacity or capability. There can be a direct correlation between the development potential of an area and the capacity and capability of available wastewater treatment. Although the availability of sewers can influence the development potential of an area, other factors such as site and locational amenities, land values, employment opportunities, transportation access, and related factors are also important factors in defining an area's overall development potential. The dynamics of these factors vary according to the characteristics of the locality.

Within the facility planning area, factors other than the availability of centralized wastewater treatment are heavily influencing population growth. St. Charles County is currently experiencing significant population growth and urbanization due to a number of factors including:

- Improved transportation access between the planning area and St. Louis;
- Existence of large amounts of vacant buildable land suitable for residential and commercial development;
- Pro-growth planning policies that serve to facilitate population growth; and
- Siting of major new employment centers in nearby areas.

Given these factors and recent trends in the demography and urbanization of the area, population growth appears to be an assumed condition rather than a result of expanded wastewater treatment capability. Therefore, the four final action alternatives would have more impact on where growth may occur rather than on absolute population growth.

Decisions concerning the amount of growth a community would like to foster, through zoning provisions, planning policies and other means, are the responsibility of the local municipal governments. It should be noted though, that the growth potential provided by the implementation of any facilities plan can have far reaching implications that should be coordinated with the community's overall goals and objectives concerning future growth and development.

4.4.2 Land Use

Land use impacts associated with any of the action alternatives are primarily related to changes from agricultural uses to urban uses, i.e., residential, commercial and/or industrial uses. Due to the availability of an expanded central collection system, growth would tend to concentrate or occur first in those areas where sewage services are available. Without development of any of the four final action alternatives, there would be more reliance on onsite systems for wastewater treatment. Therefore, development would be more likely to be dispersed. With a concentration of development in areas with sewer services, changes in land use and growth may be more orderly and impact less total land area.

4.4.3 Surface Water

Induced development and land use changes along streams and waterways could occur from any of the action alternatives and may increase nutrient and sediment loads into the waterways as a result of the following processes:

- Construction of impervious surfaces such as rooftops, parking areas, paved roads, and hard-packed soils may increase not only the amount of surface runoff, but also its ability to erode soil and to transport pollutants.
- Lawn and garden fertilization may create relatively high nutrient concentrations in runoff.
- The conventional practice of placing lawn clippings and leaf litter in drainageways may speed the process of nutrient transport.

Population growth would neither be hindered or induced significantly under any of the action alternatives. Residential population growth and housing stock growth would proceed at comparable rates regardless of which action alternative is implemented. No extraordinarily high levels of erosion-borne nutrient loads are anticipated to be generated under any single project alternative. Therefore, over the long-term, no one alternative offers an advantage of reduced secondary water quality impacts.

4.4.4 Groundwater

Increased urbanization and population growth would cause an increased demand for water supplies in the planning area. A major portion of the potable water supplies is now supplied by groundwater from the alluvial aquifers with some supply from the bedrock aquifers. Demand would increase usage of these aquifers. More withdrawals would take place by domestic, industrial, and municipal wells. Although aquifer recharge capability is available from the Mississippi and Missouri rivers, groundwater quantity and flow patterns could be affected by increased growth and urbanization. Water quality is relatively good in the planning area. With increased growth and urbanization, especially industrial growth, the potential for contamination and secondary adverse impacts to groundwater quality would increase.

4.4.5 Economics/Public Services

Economic growth should continue with the population growth and development anticipated in the planning area. Implementation of any of the action alternatives would facilitate that growth. As commercial development occurs to support the increased population, the area's economic base would expand and further shift from an agricultural economy to a service economy. The local economy would benefit from the increased tax revenues and employment opportunities. The local economy also would become more involved in the regional economy; however, these potential benefits currently are not quantifiable.

Available data indicate that the population of St. Charles County is more affluent than the rest of the St. Louis SMSA and the State of Missouri as a whole. Thus, it would be expected that few people with fixed or low incomes would be displaced from the planning area because of their inability to pay new or increased user fees associated with improved wastewater facilities. With increased population, demand for public services likewise would increase. More residential and commercial development that would accompany population growth would contribute to the tax base and provide revenues needed to finance more public services.

4.4.6 Sensitive Environmental Resources

Most sensitive environmental resources occur just outside the periphery of the planning area. Some significant wetland wildlife habitats occur along and in the Mississippi River and Missouri River, however the proposed project or associated development is not expected to significantly affect these resources. Marais Temp Clair occurs just southeast of the project area, but is likewise not expected to be affected.

4.5 Mitigation of Adverse Impacts

As previously identified, various adverse impacts would be associated with the proposed action alternatives. Many of these adverse impacts must be reduced significantly by the application of mitigative measures. These mitigative measures consist of a variety of legal requirements, planning measures, and design practices. The extent to which these measures are applied will determine the ultimate impact of the particular action. Potential measures for alleviating construction, operation, and secondary adverse effects presented in Sections 4.2 and 4.4 are discussed in the following sections.

4.5.1 Mitigation of Construction Impacts

The construction related impacts presented in Section 4.2 primarily are short-term effects resulting from land disturbing activities at the STP sites or along the routes of proposed wastewater collection and conveyance lines. Proper design would minimize the potential for adverse impacts and the engineering plans and specifications shall incorporate mitigative measures consistent with the following discussion.

The project construction documents should provide for mitigation of adverse effects from fugitive dust generation from excavation and backfilling operations for the sewer lines, force mains, and treatment plants by techniques such as frequent street sweeping of dirt from construction sites to reduce the major source of dust. Prompt repaving of roads disturbed by construction should also be considered to reduce dust persistence. Construction site, spoil piles, and unpaved access roads also may be required to be treated with a pallative periodically to minimize dust. Soil stockpiles and backfilled trenches should be seeded with a temporary or permanent vegetation, or covered with mulch to reduce susceptibility to wind erosion.

Street cleaning at sites where trucks and equipment gain access to construction sites and at roads near collection lines or force mains should be conducted to reduce loose dirt that otherwise would generate dust, create unsafe driving conditions, or be washed into roadside ditches or storm drains.

Project specifications should require that exhaust emissions and noise from construction equipment be minimized by proper equipment operation and maintenance. The resident engineer should have and exercise the authority to ban from the site all equipment which does not satisfy criteria included in the project plans and specifications. Soil borings along the proposed force main rights-of-way conducted during system design, would identify organic soils that have the potential to release odors when excavated. These areas should be bypassed by rerouting the force main if, depending on the location, a significant impact is possible.

Spoil disposal sites must be identified during the project design stage to ensure that adequate sites are available and that disposal site impacts are minimized. Landscaping and restoration of vegetation should be conducted immediately after disposal is completed to prevent or minimize impacts from dust generation and unsightly conditions.

Lands disturbed by trenching for force main construction should be regraded and compacted as necessary to prevent future subsidence. Areas disturbed by trenching and grading at the STP site also should be revegetated as soon as possible to prevent erosion and dust generation. Native plants and grasses should be used to the maximum extent possible, which also would facilitate the re-establishment of wildlife habitat.

Construction-related disruption in the community should be minimized through considerate contractor scheduling and appropriate public announcements. The state and county highway departments have regulations concerning roadway disruptions, which should be rigorously adhered to. Special care must be taken to minimize disruption of access to frequently visited establishments. Announcements should be published in local newspapers and broadcasts from local radio stations to alert drivers of temporary traffic disruptions on primary routes. Street closing and blasting schedules also should be announced by fliers delivered to each affected household or by another appropriate technique.

Planning routes for heavy construction equipment and materials must ensure that surface load restrictions are considered. In this way, damage to streets and roadways would be avoided or minimized. Trucks hauling excavation spoil to disposal sites or fill material to the STP sites should be routed along primary arterials to minimize the threat to public safety and to reduce disturbance along residential streets.

The project specifications should provide for the control of erosion and sedimentation at all construction sites. USEPA Program Requirements Memorandum 78-1 establishes requirements for control of erosion and runoff from construction activities. Adherence to the following requirements would serve to mitigate potential problems:

- Construction site selection should consider potential occurrence of erosion and sediment losses;
- Project plan and layout should be designed to fit the local topography and soil conditions;
- When appropriate, land grading and excavating should be kept to a minimum to reduce the possibility of creating runoff and erosion problems which require extensive control measures;
- Whenever possible, topsoil should be removed and stockpiled before grading begins;

- Land exposure should be minimized in terms of area and time;
- Exposed areas subject to erosion should be revegetated as quickly as possible by means of hydroseeding with a mulching or by sodding steep slopes;
- Natural vegetation should be retained whenever feasible;
- Appropriate structural or agronomic practices to control runoff and sedimentation should be provided during and after construction;
- Stabilized drainage systems (temporary and permanent systems) should be completed early to substantially reduce erosion potential;
- Access roadways should be paved or otherwise stabilized as soon as feasible; and
- Clearing and grading should not be started until a firm construction schedule is known and can be effectively coordinated with the grading and clearing activities.

The National Historic Preservation Act of 1966, Executive Order 11593 (1971), the Archaeological and Historic Preservation Act of 1974, and the 1973 Procedures of the Advisory Council on Historic Preservation require that care must be taken early in the facilities planning process to identify cultural resources and minimize adverse effects on them. The State Historic Preservation Officer must have an opportunity to determine that the requirements have been satisfied.

Known archaeological sites should be avoided. Prehistoric, historic, and architectural resources along proposed interceptor rights-of-way have been inventoried by pedestrian survey. Four sites were recorded with two sites located partially within the construction corridors. If it is not possible to avoid these sites, subsurface testing would be necessary to determine their eligibility for nomination to the National Register of Historic Places. If any additional cultural resources are found during construction, the State Historic Preservation Officer (SHPO) must be notified immediately. The State Historic Preservation Officer has been apprised of the project and is in agreement with these recommendations for archaeological resource preservation. (see letter from Mr. Michael S. Weichman, Division of Parks and Historic Preservation, to Mr. Jim Coll, Sverdrup and Parcel and Associates, Inc., dated 10 May 1984 in Appendix D, Significant Correspondence). When followed, these procedures would serve to mitigate potential adverse impact on cultural resources.

4.5.2 Mitigation of Operation Impacts

Adverse impacts related to the operation of the proposed wastewater collection systems and treatment facilities would be minimal if the facilities are designed, operated, and maintained properly. Aerosols, gaseous emissions, and odors from the various treatment processes should be controlled through responsible operation and maintenance procedures. Above-ground pumps should be enclosed and installed to minimize sound impacts.

Concentrations of the effluent constituents discharged from the STPs would be regulated by the conditions of the NPDES permits. The effluent quality is specified by the MDNR and must be monitored. Proper and regular maintenance of cluster and onsite systems also would maximize the efficiency of these systems and minimize odors released from malfunctioning systems.

Operation impacts to soils should be minimal. Operation impacts to groundwater would be minimized by proper design and construction of sewer lines, treatment facilities, and onsite systems; however, effective maintenance practices are essential to prevent leakage and failures of all systems.

Special care to control chlorination and effluent concentrations of chlorine residuals should be taken at the Spencer Creek and Mississippi River plants to minimize adverse impacts to the aquatic biota of the planning area surface waters. Tsai (1973) documented that depressed numbers of fish and macroinvertebrates were found downstream from outfalls discharging chlorinated effluents. No fish were found in water with chlorine residuals greater than 0.37 mg/l, and the species diversity index reached zero at 0.25 mg/l. Arthur et al. (1975) reported that concentrations of chlorine residuals lethal to various species of warm water fish ranged from 0.09 to 0.30 mg/l. Furthermore, chlorination of wastewater can result in the formation of halogenated organic compounds that are potentially carcinogenic (USEPA 1976). Plans for rapid mixing of chlorine and design of contact chambers to provide long contact times, however, should achieve the desired disinfection and the minimum chlorine residual discharge (USEPA 1977). Plans for chlorination systems also should provide continuous monitoring of chlorine residual (with visual and audible alarms) to ensure that chlorine residual concentrations remain within design limits.

Operational impacts resultant from power failure can include sewer backups and localized flooding in the collection system, biological system upsets, stagnation of waters, and mechanical problems in the treatment facility. To mitigate the potential for such problems, secondary power sources are required to enhance system reliability. In the document Federal Guidelines for Design, Operation, and Maintenance of Wastewater Treatment Facilities (Federal Water Quality Administration 1970), it is required that:

> All water pollution control facilities should be planned and designed so as to provide for maximum reliability at all times. The facilities should be capable of operating satisfactorily during power failures, flooding, peak loads, equipment failure, and maintenance shutdowns.

4.5.3 Mitigation of Secondary Impacts

As discussed in Section 4.4, some secondary impacts are expected to occur from implementation of any of the action alternatives. Adequate zoning, health, and water quality regulations and enforcement should minimize these impacts. Local growth management planning also would assist in regulating the general location, density, and type of growth that might occur which would serve to minimize the potential for adverse impacts from changes in population and land use.

4.6 Unavoidable Adverse Impacts

Some adverse impacts associated with the implementation of the action alternatives cannot be avoided. The centralized collection and treatment alternatives would have the following adverse impacts:

- Short-term construction dust, noise, and traffic disruptions;
- Alteration of vegetation and wildlife habitat along the sewer and force main corridors and at the STP sites;

- Erosion and siltation during land disturbing activities;
- Periodic odors associated with upgrading/conversion of wastewater and sludge handling facilities; and
- User fees for management and operation of wastewater treatment services for the residents within the proposed service areas.

4.7 Irretrievable and Irreversible Resource Commitments

The major types and amounts of resources that would be committed through the implementation of any of the action alternatives were identified in Sections 4.2 and 4.4. Each of the alternatives would include some or all of the following resource commitments:

- Fossil fuel, electrical energy, and human labor for facilities construction and operation;
- Chemicals, especially chlorine, for STP operation;
- Tax dollars for construction and operation; and
- Some unsalvageable construction materials.

For each alternative involving a STP, there is a significant consumption of these resources with no feasible means of recovery. Thus, non-recoverable resources would be lost in exchange for the proposed wastewater management system.

Accidents which could occur during facility construction and operation could cause irreversible bodily injury or death, and damage or destroy equipment and other resources. Unmitigated STP failure potentially could kill aquatic life in the immediate mixing zone. The potential accidental destruction of undiscovered archaeological sites through excavation activities also is not reversible and would represent permanent loss of the site.

5.0 LIST OF PREPARERS

This EIS was prepared by WAPORA, Inc., for the US Environmental Protection Agency, Region VII in close cooperation with the Missouri Department of Natural Resources. Part of the information developed for this EIS was obtained from the Duckett Creek Sewer District, City of St. Charles, City of St. Peters, and City of Portage des Sioux and their engineering consultants, Sverdrup & Parcel and Associates, Inc. Appreciation is expressed to these groups for the information provided as well as for the coordination of the public participation activities.

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6.0. GLOSSARY OF TECHNICAL TERMS

Activated sludge process. A method of secondary wastewater treatment in which a suspended microbiological culture is maintained inside an aerated treatment basin. The microbial organisms oxidize the complex organic matter in the wastewater to carbon dioxide, water, and energy.

Advanced secondary treatment. Wastewater treatment more stringent than secondary treatment but not to advanced waste treatment levels.

Advanced waste treatment. Wastewater treatment to treatment levels that provide for maximum monthly average BOD_5 and SS concentrations less than 10 mg/l and/or total nitrogen removal of greater than 50% (total nitrogen removal = TKN + nitrite and nitrate).

Aeration. To circulate oxygen through a substance, as in wastewater treatment, where it aids in purification.

Aerobic. Refers to life or processes that occur only in the presence of oxygen.

Aerosol. A suspension of liquid or solid particles in a gas.

Algae. Simple rootless plants that grow in bodies of water in relative proportion to the amounts of nutrients available. Algal blooms, or sudden growth spurts, can affect water quality adversely.

Algal bloom. A proliferation of one species of algae in lakes, streams or ponds to the exclusion of other algal species.

Alluvial. Pertaining to material that has been carried by a stream.

Ambient air. Any unconfined portion of the atmosphere: open air.

Ammonia-nitrogen. Nitrogen in the form of ammonia (NH_3) that is produced in nature when nitrogen-containing organic material is biologically decomposed.

Anaerobic. Refers to life or processes that occur in the absence of oxygen.

Anoxia. Condition where oxygen is deficient or absent.

Aquifer. A geologic stratum or unit that contains water and will allow it to pass through. The water may reside in and travel through innumerable spaces between rock grains in a sand or gravel aquifer, small or cavernous openings formed by solution in a limestone aquifer, or fissures, cracks, and rubble in harder rocks such as shale.

Artesian (adj.). Refers to groundwater that is under sufficient pressure to flow to the surface without being pumped.

Artesian well. A well that normally gives a continuous flow because of hydrostatic pressure, created when the outlet of the well is below the level of the water source.

Bar screen. In wastewater treatment, a screen that removes large floating and suspended solids.

Base flow. The rate of movement of water in a stream channel that occurs typically during rainless periods, when stream flow is maintained largely or entirely by discharges of groundwater.

Bed rock. The solid rock beneath the soil and subsoil.

Biochemical oxygen demand (BOD). A bioassay-type procedure in which the weight of oxygen utilized by microorganisms to oxidize and assimilate the organic matter present per liter of water is determined. It is common to note the number of days during which a test was conducted as a subscript to the abbreviated name. For example, BOD_5 indicates that the results are based on a five-day long (120-hour) test. The BOD value is a relative measure of the amount (load) of living and dead oxidizable organic matter in water. A high demand may deplete the supply of oxygen in the water, temporarily or for a prolonged time, to the degree that many or all kinds of aquatic organisms are killed. Determinations of BOD are useful in the evaluation of the impact of wastewater on receiving waters.

Biota. The plants and animals of an area.

CFS. Cubic feet per second

Chlorination. The application of chlorine to drinking water, sewage or industrial waste for disinfection or oxidation of undesirable compounds.

Circulation period. The interval of time in which the density stratification of a lake is destroyed by the equalization of temperature, as a result of which the entire water mass becomes mixed.

Clay. The smallest mineral particles in soil, less than .004 mm in diameter; soil that contains at least 40% clay particles, less than 45% sand, and less than 40% silt.

Coliform bacteria. Members of a large group of bacteria that flourish in the feces and/or intestines of warm-blooded animals, including man. Fecal coliform bacteria, particularly *Escherichia coli* (*E. coli*), enter water mostly in fecal matter, such as sewage or feedlot runnoff. Coliforms apparently do not cause serious human diseases, but these organisms are abundant in polluted waters and they are fairly easy to detect. The abundance of coliforms in water, therefore, is used as an index to the probability of the occurrence of such disease-producing organisms (pathogens) as *Salmonella*, *Shigella*, and enteric viruses which are otherwise relatively difficult to detect.

Community. The plants and animals in a particular area that are closely related through food chains and other interactions.

Cultural resources. Fragile and nonrenewable sites, districts, buildings, structures, or objects representative of our heritage. Cultural resources are divided into three categories: historical, architectural, or archaeological. Cultural resources of special significance may be eligible for listing on the National Register of Historic Places.

Debt Service Requirement. The amount of money required to pay interest on outstanding debt, serial maturities of principal for serial bonds, and required contributions to accumulate monies for future retirement of term bonds.

Decibel (dB). A unit of measurement used to express the relative intensity of sound. For environmental assessment, it is common to use a frequency-rated scale (A scale) on which the units (dBA) are correlated with responses of the human ear. On the A scale, 0 dBA represents the average least perceptible sound (rustling leaves, gentle breathing), and 140 dBA represents the intensity at which the eardrum may rupture (jet engine at open throttle). Intermediate values generally are: 20 dBA, faint (whisper at 5 feet, classroom, private office); 60 dBA, loud (average restaurant or living room, playground); 80 DBA, very loud (impossible to use a telephone, noise made by food blender or portable standing machine; hearing impairment may result from prolonged exposure); 100 dBA, deafening noise (thunder, car horn at 3 feet, loud motorcycle, loud power lawn mower).

Demographic. Pertaining to the science of vital and special statistics, especially with regard to population density and capacity for expansion or decline.

Detention time. Average time required to flow through a basin. Also called retention time.

Discount rate. The interest rate used either to discount future cash flows to a reference time (zero) or to compound past cash flows to the same reference time.

Digestor. In wastewater treatment a closed tank, sometimes heated to 95°F where sludge is subjected to intensified bacterial action.

Disinfection. Effective killing by chemical or physical processes of all organisms capable of causing infectious disease. Chlorination is the disinfection method commonly employed in sewage treatment processes.

Dissolved oxygen (DO). Oxygen gas (O_2) in water. It is utilized in respiration by fish and other aquatic organisms, and those organisms may be injured or killed when the concentration is low. Because much oxygen diffuses into water from the air, the concentration of DO is greater, other conditions being equal, at sea level than at high elevations, during periods of high atmospheric pressure than during periods of low pressure, and when the water is turbulent (during rainfall, in rapids, and waterfalls) rather than when it is placid. Because cool water can absorb more oxygen than warm water, the concentration tends to be greater at low temperatures than at high temperatures. Dissolved oxygen is depleted by the oxidation of organic matter and of various inorganic chemicals. Should depletion be extreme, the water may become anaerobic and could stagnate, causing offensive odors.

Drainage basin. A geographical area or region which is so sloped and contoured that surface runoff from streams and other natural watercourses is carried away by a single drainage system by gravity to a common outlet or outlets; also referred to as a watershed or drainage area.

Drift. Rock material picked up and transported by a glacier and deposited elsewhere.

Effluent. Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial treatment plant, or part thereof.

EIS. Environmental Impact Statement.

Endangered species. Any species of animal or plant that is in known danger of extinction throughout all or a significant part of its range.

Epilimnion. The upper layer of a thermally stratified lake or reservoir, the epilimnion, is characterized by an almost homogenous temperature, chemical, and oxygen distribution.

Eutrophication. The progressive enrichment of surface waters particularly non-flowing bodies of water such as lakes and ponds, with dissolved nutrients, such as phosphorus and nitrogen compounds, which accelerate the growth of algae and higher forms of plant life and result in the utilization of the usable oxygen content of the waters at the expense of other aquatic life forms.

Fauna. The total animal life of a particular geographic area or habitat.

Fecal coliform bacteria. See coliform bacteria.

Floodplain. Belt of low, flat ground bordering a stream channel subject to periodic inundation.

Floodway. The portion of the floodplain which carries moving water during a 100-year flood event without increasing the elevation of that flood by more than 1 foot.

Flood fringe. The part of the floodplain which serves as a storage area during a flood event.

Flora. The total plant life of a particular geographic area or habitat.

Flowmeter. A guage that indicates the amount of flow of wastewater moving through a treatment plant.

Forbs. Non-woody low vegetation species such as composites or legumes.

Force main. A pipe designed to carry wastewater under pressure.

FPRA. Facilities Plan Recommended Alternative.

Gravity system. A system of conduits (open or closed) in which no liquid pumping is required.

Gravity sewer. A sewer in which wastewater flows naturally down-gradient by the force of gravity.

Groundwater. All subsurface water, especially that part in the zone of saturation.

Holding tank. Enclosed tank, usually of fiberglass, steel or concrete, for the storage of wastewater prior to removal or disposal at another location.

Hypolimnion. The deep layer of a lake lying below the epilimnion and the metalimnion and removed from surface influences.

Infiltration. The water entering a sewer system and service connections from the ground through such means as, but not limited to, defective pipes, pipe joints, improper connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

Inflow. The water discharged into a wastewater collection system and service connections from such sources as, but not limited to, roof leaders, cellars, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross-connections from storm sewers and combined sewers, catch basins, storm waters, surface runoff, street wash waters or drainage. Inflow does not include, and is distinguished from, infiltration.

Influent. Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment facility, or any unit thereof.

Infrastructure capacity. The physical aspects of an urbanized area which support the use of that area; examples are: the volume of traffic streets can carry, the volume of fresh water supply, the amount of electrical power available and the service ability of a distribution system.

Interceptor sewer. A sewer designed and installed to collect sewage from a series of trunk sewers and to convey it to a sewage treatment plant.

Innovative technology. A technology whose use has not been widely documented by experience and is not a variant of conventional biological or physical/chemical treatment.

Lagoon. In wastewater treatment, a shallow pond, usually man-made, in which sunlight, algal and bacterial action and oxygen interact to restore the wastewater to a reasonable state of purity.

Land treatment. A method of treatment in which the soil, air, vegetation, bacteria, and fungi are employed to remove pollutants from wastewater. In its most simple form, the method includes three steps: (1) pretreatment to screen out large solids; (2) secondary treatment and chlorination; and (3) spraying over cropland, pasture, or natural vegetation to allow plants and soil microorganisms to remove additional pollutants. Much of the sprayed water evaporates, and the remainder may be allowed to percolate to the water table, discharged through drain tiles, or reclaimed by wells.

Leachate. Solution formed when water percolates through solid wastes, soil or other materials and extracts soluble or suspendable substances from material.

Lift station. A facility in a collector sewer system, consisting of a receiving chamber, pumping equipment, and associated drive and control devices, that collects wastewater from a low-lying district at some convenient point, from which it is lifted to another portion of the collector system.

Littoral. The shoreward region of a body of water.

Loam. The textural class name for soil having a moderate amount of sand, silt, and clay. Loam soils contain 7 to 27% clay, 28 to 50% silt, and less than 52% sand.

Loess. Wind transported sediments derived from fine glacial outwash materials.

Macroinvertebrates. Invertebrates that are visible to the unaided eye (those retained by a standard No. 30 sieve, which has 28 meshes per inch or 0.595 mm openings); generally connotates bottom-dwelling aquatic animals (benthos).

Macrophyte. A large (not microscopic) plant, usually in an aquatic habitat.

MDNR. Missouri Department of Natural Resources.

Mesotrophic. Waters with a moderate supply of nutrients and no significant production of organic matter.

Metalimnion. The layer of water in a lake between the epilimnion and hypolimnion in which the temperature exhibits the greatest difference in a vertical direction.

Milligram per liter (mg/1). A concentration of 1/1000 gram of a substance in 1 liter of water. Because 1 liter of pure water weighs 1,000 grams, the concentration also can be stated as 1 ppm (part per million, by weight). Used to measure and report the concentrations of most substances that commonly occur in natural and polluted waters.

Moraine. A mound, ridge, or other distinctive accumulation of sediment deposited by a glacier.

National Register of Historic Places. Official listing of the cultural resources of the Nation that are worthy of preservation. Listing on the National Register makes property owners eligible to be considered for Federal grants-in-aid for historic preservation through state programs. Listing also provides protection through comment by the Advisory Council on Historic Preservation on the effect of Federally financed, assisted, or licensed undertakings on historic properties.

Nitrate-nitrogen. Nitrogen in the form of nitrate (NO_3). It is the most oxidized phase in the nitrogen cycle in nature and occurs in high concentrations in the final stages of biological oxidation. It can serve as a nutrient for the growth of algae and other aquatic plants.

Nitrite-nitrogen. Nitrogen in the form of nitrite (NO_2). It is an intermediate stage in the nitrogen cycle in nature. Nitrite normally is found in low concentrations and represents a transient stage in the biological oxidation of organic materials.

Nonpoint source. Any area, in contrast to a pipe or other confined structure, from which pollutants flow into a body of water. Common pollutants from nonpoint sources could include sediments from construction sites and fertilizers and sediments from agricultural soils.

NPDWS. National Primary Drinking Water Standard.

Nutrients. Elements or compounds essential as raw materials for the growth and development of an organism; e.g., carbon, oxygen, nitrogen, and phosphorus.

O&M. Direct operating and maintenance costs.

Oligotrophic. Waters with a small supply of nutrients and hence an insignificant production of organic matter.

Ordinance. A municipal or county regulation.

Outwash. Sand and gravel transported away from a glacier by streams of meltwater and either deposited as a floodplain along a preexisting valley bottom or broadcast over a preexisting plain in a form similar to an alluvial fan.

Outwash plain. A plain formed by material deposited by melt water from a glacier flowing over a more or less flat surface of large area. Deposits of this origin are usually distinguishable from ordinary river deposits by the fact that they often grade into moraines and their constituents bear evidence of glacial origin. Also called frontal apron.

Oxidation lagoon (pond). A holding area where organic wastes are broken down by aerobic bacteria.

Percolation. The downward movement of water through pore spaces or larger voids in soil or rock.

pH. A measure of the acidity or alkalinity of a material, liquid or solid. pH is represented on a scale of 0 to 14 with 7 being a neutral state; 0, most acid; and 14, most alkaline.

Piezometric level. An imaginary point that represents the static head of groundwater and is defined by the level to which water will rise.

Plankton. Minute plants (phytoplankton) and animals (zooplankton) that float or swim weakly in rivers, ponds, lakes, estuaries, or seas.

Point source. In regard to water, any pipe, ditch, channel, conduit, tunnel, well, discrete operation, vessel or other floating craft, or other confined and discrete conveyance from which a substance considered to be a pollutant is, or may be, discharged into a body of water.

Present worth. The sum which, if invested now at the discount rate, would provide exactly the funds required to make all future payments.

Pressure sewer system. A wastewater collection system in which household wastes are collected in the building drain and conveyed therein to the pretreatment and/or pressurization facility. The system consists of two major elements, the on-site or pressurization facility, and the primary conductor pressurized sewer main.

Primary treatment. The first stage in wastewater treatment, in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.

Prime farmland. Agricultural lands, designated Class I or Class II, having little or no limitations to profitable crop production.

Pumping station. A facility within a sewer system that pumps sewage/effluent against the force of gravity.

Runoff. Water from rain, snow melt, or irrigation that flows over the ground surface and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Sanitary sewer. Underground pipes that carry only domestic or commercial wastewater, not stormwater.

Screening. Use of racks of screens to remove coarse floating and suspended solids from sewage.

Secchi disk. A disk, painted in four quadrants of alternating black and white, which is lowered into a body of water. The measured depth at which the disk is no longer visible from the surface is a measure of relative transparency.

Secondary treatment. The second stage in the treatment of wastewater in which bacteria are utilized to decompose the organic matter in sewage. This step is accomplished by introducing the sewage into a trickling filter or an activated sludge process. Effective secondary treatment processes remove virtually all floating solids and settleable solids, as well as 90% of the BOD and suspended solids. USEPA regulations define secondary treatment as 30 mg/l BOD, 30 mg/l SS, or 85% removal of these substances.

Sedimentation. The process of subsidence and deposition of suspended matter carried by water, sewage, or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point where it can transport the suspended material.

Seepage. Water that flows through the soil.

Seepage cells. Unlined wastewater lagoons designed so that all or part of wastewater percolates into the underlying soil.

Septic snooper. Trademark for the ENDECO (Environmental Devices Corporation) Type 2100 Septic Leachate Detector. This instrument consists of an underwater probe, a water intake system, an analyzer control unit and a graphic recorder. Water drawn through the instrument is continuously analyzed for specific fluorescence and conductivity. When calibrated against typical effluents, the instrument can detect and profile effluent-like substances and thereby locate septic tank leachate or other sources of domestic sewage entering lakes and streams.

Septic tank. An underground tank used for the collection of domestic wastes. Bacteria in the wastes decompose the organic matter, and the sludge settles to the bottom. The effluent flows through drains into the ground. Sludge is pumped out at regular intervals.

Septic tank effluent pump (STEP). Pump designed to transfer settled wastewater from a septic tank to a sewer.

Septic tank soil absorption system (STAS). A system of wastewater disposal in which large solids are retained in a tank; fine solids and liquids are dispersed into the surrounding soil by a system of pipes.

Settling tank. A holding area for wastewater, where heavier particles sink to the bottom and can be siphoned off.

Sewer, interceptor. See Interceptor Sewer.

Sewer, lateral. A sewer designed and installed to collect sewage from a limited number of individual properties and conduct it to a trunk sewer. Also known as a street sewer or collecting sewer.

Sewer, sanitary. See Sanitary Sewer.

Sewer, storm. A conduit that collects and transports storm-water runoff. In many sewerage systems, storm sewers are separate from those carrying sanitary or industrial wastewater.

Sewer, trunk. A sewer designed and installed to collect sewage from a number of lateral sewers and conduct it to an interceptor sewer or, in some cases, to a sewage treatment plant.

Sinking fund. A fund established by periodic installments to provide for the retirement of the principal of term bonds.

Slope. The incline of the surface of the land. It is usually expressed as a percent (%) of slope that equals the number of feet of fall per 100 feet in horizontal distance.

Sludge. The accumulated solids that have been separated from liquids such as wastewater.

Soil association. General term used to describe taxonomic units of soils, relative proportions, and pattern of occurrence.

Soil textural class. The classification of soil material according to the proportions of sand, silt, and clay. The principal textural classes in soil, in increasing order of the amount of silt and clay, are as follows: sand, loamy sand, sandy loam, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. These class names are modified to indicate the size of the sand fraction or the presence of gravel, sandy loam, gravelly loam, stony clay, and cobbly loam, and are used on detailed soil maps. These terms apply only to individual soil horizons or to the surface layer of a soil type.

State equalized valuation (SEV). A measure employed within a State to adjust actual assessed valuation upward to approximate true market value. Thus it is possible to relate debt burden to the full value of taxable property in each community within that State.

STP. Sewage Treatment Plant.

Stratification. The condition of a body of water when the water is divided into layers of differing density. Climatic changes over the course of the seasons cause a lake to divide into a bottom layer and surface layer, with a boundary layer (thermocline) between them. Stratification generally occurs during the summer and again during periods of ice cover in the winter. Overturns, or periods of mixing, generally occur once in the spring and once in the autumn. This "dimictic" condition is most common in lakes located in middle latitudes. A lake which stratifies and mixes more than twice per year is defined as "polymictic".

Threatened species. Any species of animal or plant that is likely to become endangered within the foreseeable future throughout all or a significant part of its range.

Till. Unsorted and unstratified drift, consisting of a heterogeneous mixture of clay, sand, gravel, and boulders, that is deposited by and underneath a glacier.

Trickling filter process. A method of secondary wastewater treatment in which the biological growth is attached to a fixed medium, over which wastewater is sprayed. The filter organisms biochemically oxidize the complex organic matter in the wastewater to carbon dioxide, water, and energy.

Topography. The configuration of a surface area including its relief, or relative evaluations, and the position of its natural and manmade features.

Unique farmland. Land, which is unsuitable for crop production in its natural state, that has been made productive by drainage, irrigation, or fertilization practices.

Wastewater. Water carrying dissolved or suspended solids from homes, farms, businesses, and industries.

Water quality. The relative condition of a body of water, as judged by a comparison between contemporary values and certain more or less objective standard values for biological, chemical, and/or physical parameters. The standard values usually are based on a specific series of intended uses, and may vary as the intended uses vary.

Watershed. The region drained by or contributing water to a stream, lake, or other body of water.

Water table. The upper level of groundwater that is not confined by an upper impermeable layer and is under atmospheric pressure. The upper surface of the substrate that is wholly saturated with groundwater.

Wetlands. Those areas that are inundated by surface and/or ground waters with a frequency sufficient to support, and under normal circumstances does or would support, a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

WWTP. Wastewater Treatment Plant.

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APPENDICES

A - Detailed Breakdown of Preliminary Costs (Present Worth) for Each of the Eight Preliminary Alternatives

B - Detailed Breakdown of Construction Cost Estimates for the Facility Plan Recommended Alternative

C - Detailed Breakdown of Annual Operation and Maintenance Cost Estimates for the Facility Plan Recommended Alternative

D - Significant Correspondence

APPENDIX A

Detailed Breakdown of Preliminary Costs (Present Worth) for Each of the Eight Preliminary Alternatives

APPENDIX A

PRELIMINARY COSTS

ALTERNATIVE 1 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Expand H-D Pump Station	170	57	17	330
	2. Harvester Interceptor	2,900	1,700	0	2,500
	3. Package Plant at South Site • contact stabilization • nitrification • disinfection • aerobic digestion	2,700	82	170	3,100
	4. Expand St. Peters Plant • convert to contact stabilization • disinfection • aerobic digestion	3,100	0	310	3,900
	5. Expand Brown Road Pump Station (Phase I)	1,200	410	33	1,500
	6. Brown Road Interceptor	1,800	1,000		1,500
	7. St. Peters Effluent Pump Station (Phase I)	2,000	680	32	2,200
	8. St. Peters Force Main to Mississippi River Plant	12,000	7,500	0	11,000
	9. South Plant Interceptor and Pump Station	1,900	1,100	30	2,000
	10. Expand Mississippi River Plant (Phase I) • raw pumping • preliminary treatment • primary settling • step aeration • disinfection • sludge thickening • aerobic digestion • effluent pumping	12,000	4,200	640	15,000

PRELIMINARY COSTS

ALTERNATIVE 1 PRESENT WORTH (continued)
($ in thousands)

Year	Item		Cost	Salvage	O&M	Present Worth
1986	11.	Upgrade Missouri River Plant • raw pumping • preliminary treatment • contact stabilization • sludge thickening • sludge to Mississippi River Plant	6,300	2,300	240	7,700
	12.	Boschertown Interceptor and Pump Station	550	310	11	540
	13.	Missouri River Interceptor	1,600	990	0	1,300
1988	14.	Abandon St. Peters Plant				
	15.	Abandon South Plant				
1990	16.	New Duckett Creek Plant • raw pumping • oxidation ditch • aerobic digestion	2,400	1,200	87	2,200
1992	17.	Brown Road Pump Station (Phase II)	850	480	47	460
	18.	St. Peters Pump Station (Phase II)	1,400	800	50	740
	19.	Expand Mississippi River Plant (Phase II)	9,400	5,300	850	8,300
				TOTAL		64,270

PRELIMINARY COSTS

ALTERNATIVE 2 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Package Plant at South Site *	2,700	84	170	3,200
	2. New H-D Plant • contact stabilization • nitrification • disinfection • aerobic digestion	7,300	2,400	400	10,700
1986	3. Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	4. Boschertown Interceptor and Pump Station	550	310	11	540
	5. Missouri River Interceptor	1,600	990	0	1,300
1988	6. South Plant Interceptor and Dardenne and South Plant Pump Stations	4,000	2,400	62	3,100
1989	7. Abandon South Plant				
1990	8. New Duckett Creek Plant*	2,400	1,200	87	2,200
1991	9. Expand Mississippi River Plant	13,000	6,900	600	12,000
	10. St. Peters Effluent Pump Station	1,400	750	32	890
	11. St. Peters Force Main to Mississippi River Plant	7,400	5,300	0	3,500
1995	12. Abandon St. Peters Plant				
					TOTAL 45,130

* See Alternative 1 for description.

PRELIMINARY COSTS

ALTERNATIVE 3 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Expand H-D Pump Station	170	60	17	330
	2. Harvester Interceptor	2,900	1,700	0	2,500
	3. Package Plant at South Site*	2,700	84	170	3,200
	4. Expand St. Peters Plant*	5,200	1,700	470	9,400
	5. Expand Brown Road Pump Station	1,900	630	47	2,200
	6. Brown Road Interceptor	1,800	1,000	0	1,500
	7. St. Peters Effluent Pump Station	2,200	750	41	2,500
	8. St. Peters Sewer to Mississippi River	5,300	3,200	0	4,600
1986	9. Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	10. Boschertown Interceptor and Pump Station	550	310	11	540
	11. Missouri River Interceptor	1,600	990	0	1,300
1988	12. South Plant Interceptor and Pump Station	1,900	1,200	30	1,500
1989	13. Abandon South Plant				
1990	14. New Duckett Creek Plant*	2,400	1,200	87	2,200
1993	15. Expand Mississippi River Plant*	8,000	4,800	470	7,800
				TOTAL	47,270

* See Alternative 1 for description.

PRELIMINARY COSTS

ALTERNATIVE 4 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Package Plant at South Site	2,700	84	170	3,200
	2. New H-D Plant[+]	7,300	2,400	400	10,700
1986	3. Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	4. Boschertown Interceptor and Pump Station	550	310	11	540
	5. Missouri River Interceptor	1,600	990	0	1,300
1988	6. South Plant Interceptor and Dardenne and South Plant Pump Stations	4,000	2,400	62	3,100
1989	7. Abandon South Plant				
1990	8. New Duckett Creek Plant*	2,400	1,200	87	2,200
	9. Expand St. Peters Plant*	2,800	1,400	280	3,200
	10. St. Peters Effluent Pump Station	1,000	500	32	760
	11. St. Peters Sewer to Mississippi River	3,100	2,200	0	1,600
1993	12. Expand Mississippi River Plant*	8,000	4,800	470	7,800
				TOTAL	42,100

+See Alternative 2 for description.
*See Alternative 1 for description.

PRELIMINARY COSTS

ALTERNATIVE 5 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Expand H-D Pump Station	1,200	390	33	1,400
	2. Harvester Force Main	0	1,900	0	400
	3. Package Plant at South Site*	2,700	84	170	3,200
	4. New Duckett Creek Plant*	7,100	2,400	250	9,000
1986	5. Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	6. Boschertown Interceptor and Pump Station	550	310	11	540
	7. Missouri River Interceptor	1,600	990	0	1,300
1988	8. South Plant Interceptor and Dardenne and South Plant Pump Stations	4,000	2,400	62	3,100
1989	9. Abandon South Plant				
1991	10. Expand Mississippi River Plant*	13,000	6,900	600	12,000
	11. St. Peters Effluent Pump Station	1,400	750	32	890
	12. St. Peters Force Main to Mississippi River Plant	7,400	5,300	0	3,500
1995	13. Abandon St. Peters Plant				
				TOTAL	43,030

* See Alternative 1 for description.

PRELIMINARY COSTS

ALTERNATIVE 6 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Expand H-D Pump Station	1,200	390	33	1,400
	2. Harvester Force Main	0	1,900	0	400
	3. Package Plant at South Site*	2,700	84	170	3,200
	4. New Duckett Creek Plant*	7,100	2,400	250	9,000
1986	5. Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	6. Boschertown Interceptor and Pump Station	550	310	11	540
	7. Missouri River Interceptor	1,600	990	0	1,300
1988	8. South Plant Interceptor and Dardenne and South Plant Pump Stations	4,000	2,400	62	3,100
1989	9. Abandon South Plant				
1990	10. Expand St. Peters Plant*	2,800	1,400	280	3,200
	11. St. Peters Effluent Pump Station	1,000	500	32	760
	12. St. Peters Sewer to Mississippi River	3,100	2,200	0	1,600
1993	13. Expand Mississippi River Plant*	8,000	4,800	470	7,800
				TOTAL	40,000

*See Alternative 1 for description.

PRELIMINARY COSTS

ALTERNATIVE 7 PRESENT WORTH
($ in thousands)

Year	Item		Cost	Salvage	O&M	Present Worth
1985	1.	Expand H-D Pump Station	500	170	27	730
	2.	Harvester Force Main	0	1,900	0	400
	3.	Package Plant at South Site*	2,700	100	170	3,800
	4.	New Duckett Creek Plant*	5,700	1,900	200	7,300
1986	5.	Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	6.	Boschertown Interceptor and Pump Station	550	310	11	540
	7.	Missouri River Interceptor	1,600	990	0	1,300
1990	8.	Expand Mississippi River Plant*	15,000	7,400	630	15,000
	9.	Expand Brown Road Pump Station	590	300	32	520
	10.	Brown Road Interceptor	1,200	840	0	640
	11.	St. Peters Effluent Pump Station	2,000	1,000	36	1,400
	12.	St. Peters Force Main to Mississippi River Plant	9,400	6,600	0	5,000
1994	13.	South Plant Interceptor and Pump Station	3,500	2,700	30	1,300
1995	14.	Abandon South Plant				
	15.	Abandon St. Peters Plant				
					TOTAL	45,630

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* See Alternative 1 for description.

PRELIMINARY COSTS

ALTERNATIVE 8 PRESENT WORTH
($ in thousands)

Year	Item	Cost	Salvage	O&M	Present Worth
1985	1. Expand H-D Pump Station	500	170	27	800
	2. Harvester Force Main	0	1,900	0	400
	3. Package Plant at South Site*	2,700	100	170	3,800
	4. New Duckett Creek Plant*	5,700	1,900	200	7,300
1986	5. Upgrade Missouri River Plant*	6,300	2,300	240	7,700
	6. Boschertown Interceptor and Pump Station	550	310	11	540
	7. Missouri River Interceptor	1,600	990	0	1,300
1990	8. Expand Brown Road Pump Station	590	300	32	520
	9. Brown Road Interceptor	1,200	840	0	640
	10. Expand St. Peters Plant	3,800	1,900	360	5,700
	11. St. Peters Effluent Pump Station	1,400	700	36	1,000
	12. St. Peters Sewer to Mississippi River	4,000	2,800	0	2,100
1993	13. Expand Mississippi River Plant*	8,000	4,800	470	7,800
1994	14. South Plant Interceptor and Pump Station	3,500	2,700	30	1,300
1995	15. Abandon South Plant				
				TOTAL	40,900

* See Alternative 1 for description.

APPENDIX B

Detailed Breakdown of Construction Cost Estimates for the Facility Plan Recommended Alternative

APPENDIX B

SELECTED PLAN
CONSTRUCTION COST ESTIMATES
(June 1984 Costs)

A. DUCKETT CREEK

		2005 Design	1985 Design
1.	Duckett Creek Plant		
	Raw pump station/bar screen	$ 570,000	$ 478,000
	Grit chamber	126,000	106,000
	Flow measurement	19,000	15,000
	Oxidation ditches	2,670,000	2,172,000
	Secondary clarifiers	651,000	530,000
	Sludge thickeners	304,000	247,000
	Aerobic digesters	425,000	346,000
	Sludge dewatering	349,000	284,000
	Sludge pump station	167,000	136,000
	Sludge disposal	448,000	364,000
	Admin./Control/Lab. building	270,000	220,000
	Maint. Shop/Garage building	239,000	195,000
	Sitework/Flood protection	1,173,000	962,000
	Yard piping	467,000	380,000
	Electrical	1,121,000	912,000
	Miscellaneous	900,000	735,000
	Subtotal	$ 9,899,000	$ 8,082,000
2.	Interim South Plant		
	Package plant	$ 520,000	$ 520,000
3.	Interim Duckett Creek Plant		
	Package plant	$ 800,000	$ 800,000
4.	South Interceptor		
	Force mains	$ 354,000	$ 284,000
	Gravity sewers	1,436,000	1,385,000
	Pump stations	367,000	299,000
	Subtotal	$ 2,157,000	$ 1,968,000
5.	Boschertown Interceptor		
	Gravity sewers	$ 341,000	$ 341,000
	Pump station	44,000	33,000
	Subtotal	$ 385,000	$ 374,000

SELECTED PLAN
CONSTRUCTION COST ESTIMATES
(June 1984 Costs) (continued)

A. DUCKETT CREEK (continued)

	2005 Design	1985 Design
6. Harvester-Dardenne Interceptor		
Gravity sewers	$ 1,020,000	$ 854,000
Subtotal	$ 1,020,000	$ 854,000
TOTAL ESTIMATED CONSTRUCTION COST:	$14,781,000	$12,598,000

SELECTED PLAN
CONSTRUCTION COST ESTIMATES
(June 1984 Costs) (continued)

B. ST. CHARLES

1. Missouri River Plant	2005 Design	1985 Design
Raw pump station/bar screen	$ 522,000	$ 449,000
Grit chamber	112,000	96,000
Flow measurement	19,000	16,000
Primary clarifiers	396,000	326,000
Intermediate lift station	126,000	104,000
Oxidation ditches	1,546,000	1,270,000
Secondary clarifiers	651,000	535,000
Sludge thickeners	113,000	93,000
Sludge pump station	93,000	77,000
Sludge dewatering	488,000	401,000
Adm./Control building	247,000	203,000
Maint. Shop/Garage building	180,000	148,000
Sitework	115,000	95,000
Yard piping	623,000	512,000
Electrical	1,168,000	960,000
Miscellaneous	640,000	526,000
Subtotal	$ 7,039,000	$ 5,811,000

2. Mississippi River Plant	2005 Design	1985 Design
Raw pumps	$ 163,000	$ -0-
Bar screen	75,000	-0-
Grit chamber	112,000	-0-
Flow measurement	24,000	-0-
Primary clarifiers	421,000	-0-
Secondary clarifier	339,000	-0-
Chlorination	612,000	510,000
Effluent pump station	237,000	198,000
Sitework	3,000	1,000
Yard piping	339,000	121,000
Electrical	436,000	155,000
Miscellaneous	138,000	49,000
Subtotal	$ 2,899,000	$ 1,034,000

3. Missouri River Interceptor	2005 Design	1985 Design
Gravity sewers	$ 1,616,000	$ 1,511,000
Subtotal	$ 1,616,000	$ 1,511,000

TOTAL ESTIMATED CONSTRUCTION COST:	$11,554,000	$ 8,356,000

SELECTED PLAN
CONSTRUCTION COST ESTIMATES
(June 1984 Costs) (continued)

C. ST. PETERS

1. Spencer Creek Plant	2005 Design	1985 Design
Grit chamber	$ 141,000	$ -0-
Aeration basin	1,634,000	-0-
Sludge thickeners	108,000	80,000
Aerobic digesters	403,000	-0-
Sludge dewatering	507,000	373,000
Sludge storage	116,000	69,000
Effluent pump station/chlorination	463,000	341,000
Sitework	177,000	130,000
Yard piping	66,000	48,000
Electrical	399,000	294,000
Miscellaneous	581,000	200,000
Subtotal	$ 4,595,000	$ 1,535,000
2. Effluent Pipe		
Force main	$ 2,371,000	$ 1,858,000
Subtotal	$ 2,371,000	$ 1,858,000
TOTAL ESTIMATED CONSTRUCTION COST:	$ 6,966,000	$ 3,393,000

SELECTED PLAN
CONSTRUCTION COST ESTIMATES
(June 1984 Costs) (continued)

D. PORTAGE DES SIOUX

1. Portage des Sioux Plant	2005 & 1985 Design
Bar screen	$ 22,000
Package plant	72,600
Aerobic digester	30,200
Sludge storage tank	60,500
Sludge pumps	13,600
Chlorination	39,600
Control building	22,700
Sludge truck	18,100
Site work	124,400
Yard piping	20,900
Controls and instrumentation	11,600
Electrical	28,700
Miscellaneous	46,500
Subtotal	$511,400
2. Portage des Sioux Transmission System	
Pump station	$ 60,500
Force main	31,800
Interceptor	43,800
Outfall	45,400
Headwall	3,000
Manholes	10,600
Miscellaneous	19,600
Subtotal	$214,700
3. North Area Transmission System	
Pump stations (15)	$ 90,700
Pressure sewers	42,300
Miscellaneous	13,300
Subtotal	$146,300
4. Northeast Area Transmission System	
Gravity sewers	$113,400
Manholes	15,100
Miscellaneous	12,900
Subtotal	$141,400
TOTAL ESTIMATED CONSTRUCTION COST:	$1,013,800

APPENDIX C

Detailed Breakdown of Annual Operation and Maintenance Cost Estimates for the Facility Plan Recommended Alternative

APPENDIX C

SELECTED PLAN
ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATES
(June 1984 Costs)

A. DUCKETT CREEK

1. Duckett Creek Plant		2005 Design
Power		$ 156,000
Labor		172,000
Materials		39,000
Chemicals		27,000
	Subtotal	$ 394,000
2. Interim South Plant		
Power		$ 37,000
Labor		24,000
Materials		16,000
Chemicals		3,000
	Subtotal	$ 80,000
3. Interim Duckett Creek Plant		
Power		$ 55,000
Labor		36,000
Materials		24,000
		$ 115,000
4. Transmission System		
Pump Stations (1)		
Power		$ 136,000
Labor		27,000
Materials		31,000
Force Main (2)		
Labor/Materials		3,000
Gravity Interceptors (3)		
Labor/Materials		6,000
	Subtotal	$ 203,000
5. Remaining Facilities (4)		
Pump Stations		
Power		$ 13,000
Labor		27,000
Materials		7,000
Sewers		
Labor/Materials		$ 39,000
	Subtotal	$ 86,000

SELECTED PLAN
ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATES
(June 1984 Costs) (continued)

A. DUCKETT CREEK (Continued)

5. Administrative		2005 Design
Salaries/Materials/Other		$ 183,000
	Subtotal	$ 183,000
TOTAL ESTIMATED ANNUAL O&M COST:		$ 866,000 (5)

Notes:

1. Includes Harvester-Dardenne, South, and Dardenne pump stations
2. Includes Harvester-Dardenne and Dardenne pump station force mains
3. Includes South interceptor
4. Includes existing sewers and pump stations
5. Assumes Interim South and Duckett Creek plants are eliminated

SELECTED PLAN
ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATES
(June 1984 Costs) (continued)

B. ST. CHARLES

		2005 Design
1. Mississippi River Plant		
Power		$ 160,000
Labor		281,000
Materials		89,000
Chemicals		55,000
	Subtotal	$ 585,000
2. Missouri River Plant		
Power		$ 119,000
Labor		163,000
Materials		39,000
Chemicals		38,000
	Subtotal	$ 359,000
3. Transmission System (5)		
Gravity Interceptor Labor/Materials		$ 8,000
	Subtotal	$ 8,000
4. Remaining Facilities (6)		
Power		$ 21,000
Labor		48,000
Materials		30,000
	Subtotal	$ 99,000
5. Administration		
Salaries/Materials/Other		$ 329,000
	Subtotal	$ 329,000
TOTAL ESTIMATED ANNUAL O&M COST:		$ 1,380,000

Notes:

5. Includes Missouri River Interceptor (Phase III)
6. Includes building maintenance, existing sewers, and pump stations

SELECTED PLAN
ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATES
(June 1984 Costs) (continued)

C. ST. PETERS

		2005 Design
1. Spencer Creek Plant		
Power		$ 110,000
Labor		172,000
Materials		47,000
Chemicals		24,000
	Subtotal	$ 353,000
2. Transmission System		
Force Main (7)		
Labor/Materials		$ 2,000
	Subtotal	$ 2,000
3. Remaining Facilities (8)		
Pump Stations		
Power		$ 24,000
Labor		36,000
Materials		14,000
Sewers		
Labor/Materials		39,000
	Subtotal	$ 113,000
5. Administration		
Salaries/Materials/Other		$ 117,000
	Subtotal	$ 117,000
TOTAL ESTIMATED ANNUAL O&M COST:		$ 585,000

Notes:

7. Includes Spencer Creek Plant effluent line to the Mississippi River
8. Includes existing sewers and pump stations

SELECTED PLAN
ANNUAL OPERATION AND MAINTENANCE
COST ESTIMATES
(June 1984 Costs) (continued)

D. PORTAGE DES SIOUX

1. Portage des Sioux Plant		2005 Design
Power		$ 3,400
Labor		16,400
Materials		6,000
	Subtotal	$ 25,800
2. Transmission System		
Power		$ 1,400
Labor		4,000
Materials		1,200
	Subtotal	$ 6,600
TOTAL ESTIMATED ANNUAL O&M COST:		$ 32,400

APPENDIX D

Significant Correspondence

MISSOURI DEPARTMENT OF NATURAL RESOURCES
P.O. Box 1368 2010 Missouri Blvd. Jefferson City, Missouri 65102 (314) 751-3241

April 27, 1984

Mr. Robert B. Barbour, P.E.
Sverdrup and Parcel
800 North 12th Boulevard
St. Louis, Missouri 63101

RE: C291168-01 - Duckett Creek Sewer District

Dear Mr. Barbour:

The draft Facility Plan for the Duckett Creek Study Area has been reviewed by the Missouri Department of Natural Resources, Environmental Protection Agency and WAPORA. I have incorporated comments from all three into this letter. Comments are as follows:

1. Since the draft was completed, the results of stream studies conducted by the Missouri Department of Natural Resources have become known. As a result of the studies, the Department is planning to designate the Dardenne Creek watershed as protected (no discharge) upstream of I-70 and plans to require ammonia limits on discharges downstream of I-70. Please make any necessary revisions.

2. Due to the significant growth in population that you have projected, construction staging may be an attractive alternative in some of the cases. Please provide comparative costs. Since funding will be limited to existing needs, the final decision on staging would lie with the grantee.

3. Please provide the basis of the assumption that infiltration will increase by 1% per year.

4. The percentage of I/I appears to be significantly higher in the draft report than in the I/I analysis for each system. Please review.

5. You are reminded that pumping the effluent from the Spencer Creek Plant to the Mississippi River in lieu of providing advanced treatment will have to go through an Environmental Protection Agency (EPA) Advanced Treatment Review. This will also be required for the elimination of the Harvester - Dardenne plant if federal funds are used.

6. Many of the facilities which are exceeding their permit limits are operating at well below design capacity. To what extent could optimization of the existing facilities alleviate these problems?

Christopher S. Bond Governor
Fred A. Lafser Director

Division of Environmental Quality
Robert J. Schreiber Jr., P.E. Director

7. It appears that grant funds may be available as early as FY 86 for Duckett Creek Sewer District and FY 87 for St. Peters. It would take several years at the current level of appropriations to fund St. Charles. Please revise your projected construction scheduling to be compatible with this.

8. Do you feel the South Plant Expansion is still warranted in light of the expected funding schedule? It is extremely unlikely that such a short term expansion would be considered grant eligible.

9. Trickling filter plants are now a more viable alternative since the recent revisions to the Secondary Regulations. Please include trickling filters in your cost analysis.

10. Please submit the cost analysis for providing nitrification at the St. Peters Plant.

11. The City of St. Peters has written a letter commenting on the proposed 1/2 MGD expansion of their plant as being "too little - too late." Please respond.

12. Page 3-14 refers to occasional flooding of the St. Charles Missouri River Plant. Please explain the cause and what is being done or what should be done to correct it.

13. Please provide expected volume of ash to be generated at the Mississippi Plant and on-site storage capacity.

14. Sludge storage requirements and costs for disposal should be further developed for the Duckett Creek Plant. Suitable land application sites should be located.

15. The proposed sludge alternatives for St. Peters should be modified to be compatible with the recent purchase of a sludge truck.

16. The paragraph at the bottom of Page 7-5 indicates that costs common to all alternatives were not included in the comparison. To accurately describe alternatives and to avoid confusion, absolute costs should be used.

17. Since the various alternatives have differing grant eligibility, differing legal, financing and acquisition costs as well as different capital and O & M requirements, the cost evaluation of alternatives requires review of all costs before the cost impacts of each alternative can be completely determined.

18. In discussing geological or soil aspects of IHTS's, SCS is referenced but never Missouri Department of Natural Resources - Division of Geology and Land Survey (DGLS). DGLS has developed criteria for evaluating sites for IHTS's which are specifically applicable to Missouri. Their system is the basis for establishing a new prioritization of unsewered communities needs list which will directly impact all such proposed projects covered by the facility plan.

19. Small flow treatment plants and IHTS's could possibly have their treatment enhanced if conservation devices and practices were implemented. Please consider this in your recommendations.

20. The investigation of existing conditions and alternative solutions considered for the floodplain area were insufficient. The chosen alternative was not implementable. Existing conditions have the potential of health risks at multiple sites, which could be substantially reduced by much simpler solutions.

21. Page 5-50 states that I/A systems are generally applicable to small flow situations and are therefore not considered in the facility plan. We disagree with this statement and strongly encourage serious consideration of such systems.

22. Considering the use of the BMTS as not feasible due to the fact that it is no longer considered innovative is somewhat premature. By the time that design begins on the proposed plants there may be operational data available from full scale BMTS plants. Documented savings in construction and/or operating costs may enhance the attractiveness of this technology, regardless of priority point or grant percentage considerations.

These comments are offered for your consideration and reply. If you should have any questions, please feel free to call.

Sincerely,

Rod Breuer

Rodney K. Breuer, E.I.T.
Project Engineer
Water Pollution Control Program

RKB/csv

cc: Joe Nichols - Duckett Creek Sewer District
Barry Smith - Duckett Creek Sewer District
Earl Holtgraewe - City of St. Peters
Environmental Protection Agency
St. Louis Regional Office

MISSOURI DEPARTMENT OF NATURAL RESOURCES
P.O. Box 176 Jefferson City, Missouri 65102 (314) 751-2479

May 10, 1984

Mr. Jim Coll
Sverdrup & Parcel & Associates, Inc.
801 North Eleventh
St. Louis, Missouri 63101

Re: Proposed Interceptor Alignments, Lower Dardenne Creek,
St. Charles County, Missouri (EPA)

Dear Mr. Coll:

The Historic Preservation Program has reviewed the May 1984 report entitled "Intensive Archaeological, Historical, and Architectural Survey of Proposed Interceptor Alignments for Lower Dardenne Creek Facilities Planning Area, St. Charles County, Missouri" by Dr. Reed Lee. Based on this report, it is evident a thorough and adequate cultural resource survey has been made of the project area.

We agree with the investigator's recommendations as outlined on pages 49-51 of the report. If at all possible, the proposed project should be redesigned to avoid archaeological sites 23SC607, 23SC606, and 23SC604. If this is not feasible, the following course of action is strongly recommended. Sub-surface archaeological testing of the above listed sites which are potentially eligible for inclusion in the National Register, should be initiated with the results submitted to the Missouri Historic Preservation Program and to the Keeper of the National Register, Washington, D.C. to ascertain eligibility for inclusion in the National Register. This process is stated in 36CFR Part 63 Determination of Eligibility for Inclusion in the National Register of Historic Places.

In the event these sites are determined eligible, then the appropriate course of action as outlined in the Advisory Council on Historic Preservation's regulation Protection of Historic and Cultural Properties 36CFR Part 800, Section 800.4 should be implemented.

Pending completion of this process, no action should be taken that would affect consideration of alternatives to avoid or satisfactorily mitigate any adverse effects on the archaeological sites 23SC607, 23SC606, and 23SC604.

If I can be of further assistance, please call 314/751-4096 or write.

Sincerely,

DIVISION OF PARKS AND HISTORIC PRESERVATION

Michael S. Weichman
Chief, Review & Compliance

MSW:jdc

cc: David Browman
Ron Redden
Wes. Bartley
[redacted]

Wake up to Missouri State Parks

Christopher S. Bond Governor
Fred A. Lafser Director

Division of Parks and Historic Preservation
John Karel Director

Sverdrup

Sverdrup & Parcel and Associates, Inc.
801 North Eleventh
St. Louis, Missouri 63101
314/436-7600
TWX 910-761-1085
Cable SPECO St. Louis

Engineers
Architects
Planners

August 31, 1984

Mr. Rodney K. Breuer
Missouri Department of Natural Resources
P.O. Box 1368
Jefferson City, Missouri 65102

Dear Mr. Breuer:

Subject: Duckett Creek 201
Project C291168-01

Regarding your April 27, 1984 comments on the Draft 201 Facility Plan for the Duckett Creek Study Area, we offer the following responses to your comments by number:

1. Redesignation of Dardenne Creek.

   Revisions to the 201 Report have been made indicating the proposed protected status of Dardenne Creek upstream of I-70 and the likelihood of ammonia limits downstream of I-70.

2. Construction Staging Costs.

   Staging may be appropriate for the Duckett Creek or the Missouri River plants. Both of these facilities consist mostly of new construction. Ten-year and 15-year staging costs are presented in Exhibit 1. The Duckett Creek Plant costs correspond to 4.3- and 4.7-mgd plants for the years 1995 and 2000, respectively. Missouri River Plant costs correspond to 4.0- and 4.3-mgd plants for 1995 and 2000, respectively.

   Expansion projects are not likely to be staged for less than 20 years due to the difficulties involved in expanding an existing facility.

3. Inflow/Infiltration Rate Increase.

   The one percent per year I/I allowance used in the Draft 201 is an engineering assumption used by S&P to account for additional I/I from deteriorating pipe and expanding collection systems in the future.

   In 1985, I/I makes up 32% of the average flow. To keep the same percentage in the year 2005, I/I would have to increase by 2% per year (compounded annually). We chose a slightly lower value in view of improved sewer construction methods and materials for future growth. Using a 1% per year rate, the amount of I/I estimated for 2005 is 26% of the average flow.

4. Percentage of I/I in Draft 201 versus the separate I/I Report.

According to our calculations, the percentages of I/I to the average flow compare favorably.

Area	Draft 201 Report I/I : Avg. Flow	I/I Report I/I : Avg. Flow
Mississippi River	38%	32%
Missouri River	60%	53%
Spencer Creek	6%	4%
Duckett Creek	14%	13%
Harvester-Dardenne	14%	13%

Differences may be attributed to the different time periods involved. The flows in the 201 Report are 1985 estimates and the values in the I/I Report are based on 1981 and 1982 data.

5. EPA Advanced Treatment Review.

We understand that EPA Advanced Treatment Review may be necessary.

6. Optimization of Existing Facilities.

There is no doubt that improving effluent quality at facilities that are operating below design loadings and violating effluent limits would enhance environmental conditions. At the time the data was analyzed, the following plants (that reported flow) were operating below capacity and were not consistently meeting effluent limits:

a. Harvester-Dardenne Plant
b. Missouri River Plant
c. St. Charles Trails Plant
d. Heatherbrook Lagoon
e. Spencer Creek Plant

Currently, only St. Charles Trails, Heatherbrook, and Spencer Creek facilities are operating below their design flow capacities. Spencer Creek and St. Charles Trails plants have adequate equipment to meet permit limitations. Improved operational control is necessary. Heatherbrook lagoon is more difficult to control. Continued efforts to keep algae growth down is recommended until the lagoon can be eliminated by a new interceptor.

7. Construction Scheduling.

Projected construction schedules have been revised and are attached as Exhibit 2.

8. South Plant Expansion

South Plant expansion is necessary. The existing plant capacity is 80,000 gpd. Current flow is in the range of 50,000 to 60,000 gpd and several areas are scheduled to connect to the system in the near future. By the time an interceptor is constructed and the new Duckett Creek Plant is ready to accept the South Area flow, the existing South Plant flow is expected to be 0.5 mgd. Additional capacity is needed. Costs for a 0.5 mgd interim package plant are now included in the 201 cost estimates.

9. Trickling Filter Costs

Trickling filter costs were analyzed in view of the proposed revised definition of secondary treatment. CAPDET was used and costs are presented in the 201 Report. Trickling filters appear to be cost competitive at the Duckett Creek and Missouri River plants and it is recommended that trickling filters be considered during design. See Exhibit 3.

10. Cost Analysis for Nitrification at the St. Peters Plant.

The CAPDET cost analysis for nitrification at the St. Peters Plant is attached. See Exhibit 4.

11. St. Peters' Comment on 1/2 mgd Expansion.

Based on the current flow at the Spencer Creek Plant, flow estimates were revised for St. Peters. This changed the 20-year design flow from 3.5 to 4.0 mgd. Scheduling, costs, and user charges were also changed to reflect the additional flow.

12. Flooding of Missouri River Plant.

Wording in the text of the report was changed from "flooding" to "sewage backup." Problems stem from hydraulic overloading at the plant, not high river stages. 201 recommendations of plant upgrading and expansion will alleviate this problem.

13. Ash Generation at Mississippi River Plant.

Ash generation has been estimated and incorporated into the report. See Exhibit 5.

14. Sludge Storage Requirements and Disposal Costs for the Duckett Plant.

Sludge storage requirements, potential land application sites, and disposal costs for the Duckett Creek Plant have been added to the report. See Exhibit 6.

15. St. Peters' Purchase of a Sludge Truck.

St. Peters' pending sludge truck purchase was known to S&P during development of the Draft 201 and its use is expected in the recommended plan. Appropriate report changes have been made.

16. Costs Common to All Alternatives.

Costs have been revised to include costs common to all alternatives in Tables 6-3 and 7-2. See Exhibit 7.

17. Local Costs for EIS Cost Impact Analysis of Alternatives.

Table 7-2, Evaluation of Alternatives, has been expanded to include approximate local shares for the different sewer districts.

18. MDNR Division of Geology and Land Survey (DGLS).

The DGLS evaluation criteria for evaluating IHTS sites were reviewed and incorporated into the 201 Report. See Exhibit 8.

19. Flow Conservation Devices and Practices.

Flow conservation devices and practices were considered and are recommended. This has been included in the 201 Report. See Exhibit 9.

20 Flood Plain Plan

Additional flood plain solutions were considered and a number of non-capital-intensive recommendations are proposed for the flood plain communities. See Exhibit 10.

21. I/A Systems.

We have seriously considered a number of I/A systems and have added more discussion to the text in an attempt to reflect this. With the exception of the Draft 201 flood plain recommendation, however, we are confident with the selected plan. See Exhibit 11.

22. Use of BMTS.

We have decided to delete the BMTS discussion from the text. If necessary, additional consideration can be given to this process prior to final design.

A number of other changes to the Draft 201 have been made for incorporation into the final report. Major changes are identified and presented in an Appendix to this letter.

We hope that we have answered your questions on the Draft 201. Please contact us if you have additional questions. The Final Facility Plan will be distributed in a few weeks.

Very truly yours,

SVERDRUP & PARCEL AND ASSOCIATES, Inc.

Robert B. Barbour
Project Manager

cc: Joe Nichols, DCSD
Barry Smith, DCSD
Earl Holtgraewe, St. Peters
Tom Lorenz, EPA
Blane Work, MDNR--St. Louis
Keith Whitenight, WAPORA
Russel Stults, WAPORA

WAPORA, Inc. Environmental/Energy/Economic Studies

6900 WISCONSIN AVENUE, CHEVY CHASE, MARYLAND 20815
PHONE - (301) 652-9520

21 December 1984

Mr. Tom Lorenz
U.S. EPA
324 East Eleventh Street
Kansas City, Missouri 64106

RE: Duckett Creek Missouri Draft EIS
Project # 1563

Dear Tom:

Thank you for taking the time to meet with us to discuss the review comments made on the Pre-Draft EIS for Duckett Creek. As a result of that meeting, we are asking that your office contact the Missouri DNR for State resolution or endorsement of the following items which are required to enable completion of the Draft EIS:

(1) Does the State agree with Sverdrup & Parcel's 1% per year increase in I/I?

(2) Should estimated wasteloads of BOD & TSS be calculated on the basis of per capita contributions rather than using I/I - dependent combined flows with an assumed uniform waste strength?

(3) It should be affirmed that an AT review will be required to pump or pipe Spencer Creek plant effluent to avoid upgrading the plant.

(4) Will EPA comments on the applicability of I/A solutions to situations involving flows of greater than 1mgd or 5mgd and the ability to receive funding for the Burns and McDonnell treatment system be included in the Final Facility Plan?

(5) A specific sludge management program needs to be proposed for the planning area. The program should discuss year-round ultimate disposal.

Additionally, we ask that you please provide us a "Technical Report Sheet" for the back of the Draft EIS and an example cover sheet which we may follow and prepare for the Regional Administrators signature.

Thank you for your assistance in this matter. We are proceeding with other changes in the text and will address these items as soon as the State response is received.

Sincerely,
WAPORA, Inc.

D. Keith Whitenight

D. Keith Whitenight
Regional Director

cc: Mr. Russel G. Stults

MISSOURI DEPARTMENT OF NATURAL RESOURCES
P.O. Box 1368 2010 Missouri Blvd. Jefferson City, Missouri 65102 (314) 751-3241

January 8, 1985

Mr. Edward C. Vest
Environmental Protection Agency
Region VII
324 East 11th Street
Kansas City, Missouri 64106

RE: C291168-01 - Duckett Creek Sewer District

Dear Mr. Vest:

Following is a response to your December 17, 1984 letter on the above referenced project. The numbered responses correspond to the same numbered comments.

1. Our original comment letter to Sverdrup and Parcel questioned the estimated increase in I/I. We found their response to be reasonable and we concur.

2. For existing systems we require waste load calculations to be based upon the actual waste strength plus an allowance for growth. We feel this has been done.

3. In light of the difficulties of preparing a single planning document for three major entities and several smaller ones, we feel that sludge management has been addressed as extensively as practical at this time.

4. Further details on the land application design should be addressed in preliminary design phases. The design must conform with State Regulations and guidelines which include storage requirements.

I hope this has clarified our position on the issues in questions. If you should have any questions, please feel free to call.

Sincerely,

Rod Breuer

Rodney K. Breuer, P.E.
Project Engineer
Water Pollution Control Program

RKB/cw

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Christopher S. Bond Governor
Fred A. Lafser Director

Division of Environmental Quality
Robert J. Schreiber Jr., P.E. Director

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VII
324 EAST ELEVENTH STREET
KANSAS CITY, MISSOURI - 64106

January 11, 1985

MEMORANDUM

SUBJECT: Duckett Creek Pre-draft EIS

FROM: Thomas M. Carter
Chief, Construction Grants Branch

TO: Ed Vest
Chief, Environmental Review Branch

Your memo of December 14, 1984, asked two specific questions concerning the Duckett Creek facility plan/EIS. Our comments are as follows:

1. Concerning the need for an AT review if effluent from the Spencer Creek plant is transported to the Mississippi River to avoid upgrading this plant to provide advanced treatment: The A/E's cost estimates (given in response to DNR's facility plan comment letter) indicate that it may cost more to discharge secondary effluent to the Mississippi than to build an AT plant with discharge to Spencer Creek. If this is true, the failure to evaluate any facility plan alternatives with discharge to Spencer Creek amounts to a blanket zero discharge restriction on Spencer Creek. Under the May 21, 1984, AT policy, such a project must be reviewed by EPA Headquarters if the capital cost of the remote discharge alternative exceeds by more than $3 million the capital cost of providing only secondary treatment with nearby discharge. (Interestingly, if the capital cost difference is less than $3 million, the AT policy does not apply at all.) Cost estimates(June 1984) contained in the facility plan indicate that the capital cost difference for the Spencer Creek facilities is about $2.83 million (assuming that the $463,000 effluent pump station with chlorination will not be needed without the force main to the Mississippi River). This figure is close to the $3 million criterion, and indicates a need for further evaluation of this project prior to actual grant funding. We are not requesting an AT review by Headquarters at this time, but the facility plan/EIS should note the possibility of such a review prior to grant funding.

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2. Concerning the Burns and McDonnell treatment system and the general applicability of I/A solutions where design flows exceed either 1 MGD or 5 MGD: We acknowledge no cutoff line, above which I/A solutions need not be considered. On the contrary, larger projects usually have the potential to save more money through value engineering or I/A technology than smaller projects. We understand Missouri has determined that the Burns and McDonnell treatment system is no longer innovative, and that the consultant need not evaluate the BMTS at this time. We do not object to the State's decision on this matter, and will not mandate that BMTS be evaluated as a treatment process alternative.